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Plant Tests of a Low-Head Hydro-Electric Development

By F. Nagler*

The Centralia Pulp & Water Power Co., of Grand Rapids, Wis., has recently placed in operation, on the Wisconsin River, a low-head hydro-electric development for supplying power to the Nekoosa-Edwards Paper Co.'s mills at Port Edwards and Nekoosa, Wis., which were among the first to abandon complicated line-shaft transmission and use simple and direct motor drives.

At the outset it was recognized that the single-runner vertical-shaft turbine was most favorable to high efficiency and to simplicity of station arrangement. Recent improvements in high-speed runners have been very marked and it was found that the cost of single-runner, direct-connected units of suitable size would not be materially different from that of multiple-runner machines at higher speeds. Further, it was found that the power house would be less expensive by reason of its greater simplicity, and this feature, combined with the higher efficiency, decided the type of the installation.

On account of its being the first plant of its kind using high-capacity runners for a low head, very exacting guarantees of power and efficiency were required, with the understanding that carefully conducted tests would be made. It is the writer's purpose to describe briefly the general layout of the plant, but more particularly to outline the power, efficiency and speed-regulation tests at the plant.

Fig. 1. Generating Room, Grand Rapids Station of Centralia Pulp & Water Power Co.

Generating Station

The appearance of the generator room is seen from Fig. 1. Fig. 2 gives a cross-sectional view through one of the main turbine pits. Simplicity is the keynote of the entire plant. The headgate arrangement in particular is extremely plain but ingenious, and has proved very satisfactory in actual operation. The headgate slots are in the main generator room. Each turbine pit has a center column as the span is too great for a single gate. Two gates of structural steel are provided and are ordinarily kept in a slot at the end of the power house. They are provided with eye-bolts and lifting hooks so that they

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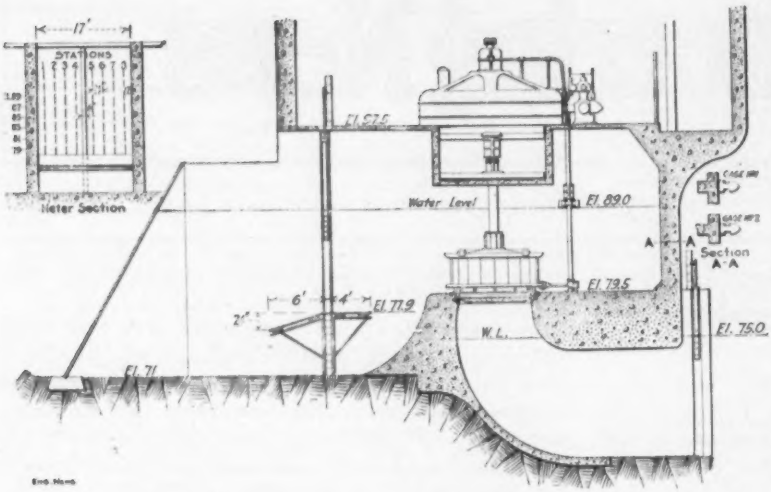


FIG. 2. CROSS-SECTION THROUGH A MAIN UNIT, SHOWING TEST ARRANGEMENTS

can be easily handled by the station crane. Wooden sills are provided at the bottom so as to insure practically a water-tight fit. For most extreme conditions, a few shovelfuls of cinders serve to make the gate so tight that a 6-in. flume drain will carry away all leakage. This drain is placed along the sloping face of the concrete immediately upstream from the turbine proper, so that the pit floor around the turbine is absolutely dry. One of the main gates is provided with a filler gate so as to prevent the necessity of lifting the gates against full operating pressure. Besides the trash rack at the station, there is additional protection against floating material, particularly ice, by a concrete guard structure at the forebay entrance adjacent to the dam. An apron extends some feet below water surface, and between supporting piers is a special trash rack with bars on 6-in. centers.

The plant comprises four 590-hp. 500-kv.-a. 90-r.p.m. hydro-electric units designed for a normal head of 13 ft. Two 90-kw. exciter units are provided, one turbine driven and the other motor driven. Power is transformed from 2300 volts to 15,000 by three 650-kv.-a. single-phase oil-filled water-cooled transformers; one spare is provided. The energy is transmitted about 10 miles, the paper mills in Nekoosa and Port Edwards consuming entire output.

MAIN UNITS—The main units are of the three-bearing type, with the thrust bearing located on top of the generating housing so that the main shaft is entirely in tension. This places the most important working parts on a single operating floor, though there is a light inspection floor underneath the generator to permit of working below the rotor and around the jackshaft from which the governor flyballs and oil pump are driven. Large manholes through this inspection floor, which runs the entire length of the building, permit of entrance to the separate turbine pits. The weight of each generator frame and rotating part of the unit is carried on concrete and steel beams which span the turbine pits. The entire unit, including turbine, generator and governor, was designed together to secure better coördination of parts, to insure a structure free from all vibration even under runaway speed conditions, and to maintain very close speed regulation.

Not only the runner but also the entire guide case and flaring covers were of the same design as the Holyoke test model. The runner (Fig. 3) is constructed of plate steel vanes cast-welded in a cast-iron crown plate and discharge ring. The runner has a nominal diameter of 64 in., the outside diameter being about 8 ft. The main turbine guide bearing is located on the cover plate immediately above the runner, and is of the water-lubricated lignum-vitæ type with adjustable bearing blocks. The cover plate itself is rigidly connected to the walls of the pit by cast-iron columns in order to insure absolute alignment.

As is common in low-head plants of this kind, the desirable limits of excavation practically fixed the form of the draft tube. This was built of gradually increasing section, the exit velocity being under 3 ft. per sec.* The exciter turbine is provided with a straight, tapered draft tube of plate steel, as the turbine is of such size (28-in. runner) that a prohibitive amount of excavation was not required.

The generators are designed with a heavy upper housing, which contains the upper steady bearing and supports the main thrust bearing. The collector rings are located on a shaft extension above the thrust bearing, the leads to the rotating field being carried down through the shaft (bored out) to the rotor. The rotor itself has a very heavy rim in order to assist in securing the close speed regulation required for a paper-mill supply.

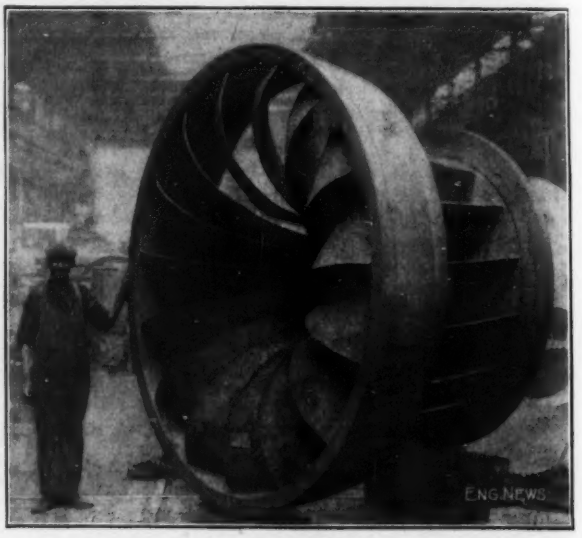


FIG. 3. LOW-HEAD HIGH-SPEED RUNNER OF GRAND RAPIDS TURBINES

The thrust bearings are of the plain-disk type, the bearing surfaces operating submerged in a bath of oil. They are completely inclosed and the rotating element

*In building this draft tube, a complete form was made, placed in position and the concrete poured around it. These wooden forms cost $150 each, including all material and labor and a special construction house and layout floor where the forms were made. It took four men about ten hours to place each form in position ready for pouring the concrete, and the total cost, including all charges, was considerably under $200 per unit for the main tubes.

produces a continuous circulation of oil. Water-cooling coils are placed within the housing. The bearings run at a temperature very slightly above room temperature.

The governors are of the oil-pressure type and are direct-connected to the gate-operating mechanism without the use of any gearing. Lost motion in the mechanical connections has been reduced as far as possible. The regulating shaft is of very large diameter to reduce torsional deflection. The flyballs (inclosed) are driven from a horizontal jackshaft geared to the main shaft. A rotary oil pump (250 lb. pressure), belt driven from the same jackshaft, together with the regulating cylinder, is located in the governor housing which supports the flyballs. The receiving tank is located below this housing, while the pressure tank (plate steel) is located at some distance. Cold-drawn seamless steel tubing with rolled flanges and brass valves is used for the distribution of oil.

The main generating equipment, including turbines, governors, generators, exciter sets and transformers, was furnished by the Allis-Chalmers Manufacturing Co., the exciter governor by the Woodward Governor Co., and the switchboard by the General Electric Co.

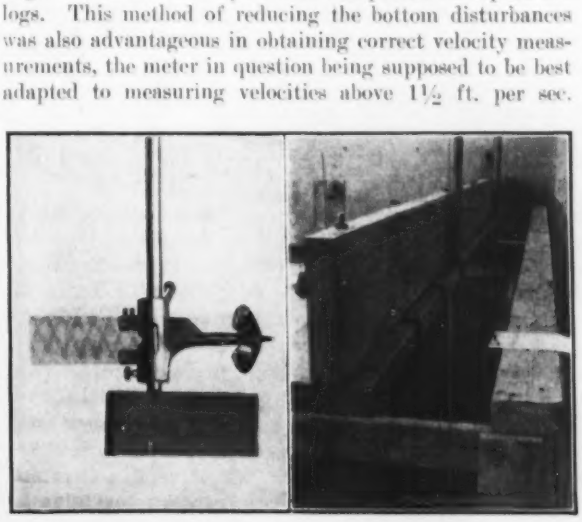
Tests

Careful tests were made to determine the capacity, efficiency and speed regulation of the machinery as installed. Furthermore, the unit was permitted to operate at full runaway speed with the turbine gates wide open and with no load on the generator. In determining capacity the output of the generator was measured by two single-phase indicating wattmeters (laboratory instruments), which were calibrated both before and after the tests. For determining efficiency it was necessary to obtain also the exact operating head and the quantity of water consumed. Speed-regulation tests were made by building up successively the various loads desired, suddenly opening the main generator switch and noting both the speed rise and the time required to resume normal speed.

The operating head was measured by special head and tail gages set and checked before the test work was performed and rechecked afterwards by means of a surveyor's level. Gage barrels were made of 4-in. iron pipes capped at their lower ends and drilled with a large number of ½-in. holes placed on a vertical line. These were wedged into the gate slots in such a position that the holes were flush with the side walls of the flume and the flow of water was tangent to them. Tin floats were used, provided with ¼-in. iron rods which extended up to a gage board. It was feared that the use of iron barrels would cause more or less trouble in midwinter work, but very little difficulty from freezing was experienced, even though the temperature was from 10 to 20° F. during most of the tests.

The quantity of water was measured immediately up stream from the turbine by determining the average velocity past a measuring section of known area. (See Fig. 2.) In determining average velocity, the flume was divided into squares approximately 2 ft. on a side, and the meter rig so arranged that the meter could be placed at the central point of each of these divisions. Depending on the depth of water, either 42 or 48 individual readings were taken for each run. The average of these readings, as determined by integrating the velocity curves, was taken as the average velocity over the cross-section.

It was originally desired to measure the velocities in the flume exactly as it is used in ordinary operation, but examination of the flow conditions by means of an indicator showed that the abrupt rise in the flume bottom immediately down stream from the only available measuring section caused a considerable disturbance and eddy currents which would introduce decided inaccuracies in the determination. On this account a tier of stop logs about 6½ ft. high was placed in the bottom of the gate slot, the top of these logs being slightly below the level of the turbine base. In order to reduce disturbances over the top of these logs, a platform extending horizontally about 4 ft. down stream and inclined at a slight angle for about 6 ft. up stream was placed on top of the logs. This method of reducing the bottom disturbances was also advantageous in obtaining correct velocity measurements, the meter in question being supposed to be best adapted to measuring velocities above 1½ ft. per sec.



Figs. 4 and 5. Current Meter and Position Frame

The only other effect of this stop-log arrangement is probably to the disadvantage of the turbine in that the higher velocities resulting from its use will probably produce more disturbance in the turbine pit, but this effect was considered to be negligible, as average velocities at all times were below 3 ft. per sec.

An accurately rated current meter of the screw type was used (an Ott instrument furnished by the Keuffel & Esser Co.) and is shown in Fig. 4. This was supported at the lower end of a 2-in. pipe which was drilled and arranged so that it could be readily shifted from one position to another, either horizontally or vertically. A plank support was provided, as shown in Fig. 5, to facilitate shifting. The arrangement was very simple, but worked out very satisfactorily in actual use, it being possible to take the 42 or 48 readings in about 35 min.

The number of revolutions were counted simultaneously by two observers. Practically all readings were over ½ min. in duration. Two telephone receivers were inserted in the meter circuit so that the observers could check one another. Alternating current was used to operate these receivers, and proved very satisfactory, as absolutely no difficulty was experienced with the contact points of the meter. It might be mentioned that the meter in question was equipped with two contact points so arranged that the buzz was divided into two parts, one short and one long. This arrangement was provided for

TABLE I. SUMMARY OF EFFICIENCY TESTS: CENTRALIA PULP & WATER POWER CO., GRAND RAPIDS, WIS., DEC. 28-30, 1913

Run No.	Day (1)	Gate Opening In. (4)	Av. Water Elev. Head (6)	Tail 2 (7)	Tail 1 (8)	Section Area, Sq.Ft. (9)	Mean Vel., Ft. per Sec. (10)	Generator Kw. Output (11)	Losses (12)	Input (13)	Turb. Net Eff. Head (6-7) (19)	Input Cu.Ft. per Sec. (9x10) (21)	Hp.[2] (24)	Turb. Output Hp. at 6-in. Gate (26)	Per Cent. Capacity (24/26) (27)	Plant Effy. Overall (31)	Turbine Effy. Guarantee (32)	Obtained (33)	
1	Dec. 28	7.00	90.32	74.98	74.93	205.0	2.64	536	27.8	564	15.34	541.5	759	750	101.0	76.3	....	80.50	Overgate
1a[1]	Dec. 28	7.50	90.27	74.97	74.92	204.2	2.70	536	27.8	564	15.30	552.0	759	748	101.3	75.0	....	79.40	Overgate
2	Dec. 29	6.40	88.83	75.65	75.62	180.4	2.552	423	21.9	445	13.18	461.0	600	614	97.7	82.3	84.0	87.00	
2 ck.[1]	Dec. 29	6.40	88.71	75.35	75.38	178.5	2.660	430	22.1	452.1	13.36	475.0	608	625	97.3	80.2	84.2	84.60	?
2a[1]	Dec. 29	7.50	88.65	75.21	75.18	177.4	3.150	440	22.3	462.3	13.44	559.0	623	630	99.0	69.2	....	73.00	Overgate
3	Dec. 29	6.25	88.81	75.07	75.00	180.2	2.62	448	22.9	470.9	13.74	472.5	635	647	98.0	81.4	83.8	86.20	
4	Dec. 29	6.75	88.83	75.10	75.04	180.4	2.782	456	23.3	479.3	13.73	503.0	645	645	100.0	78.0	82.0	82.50	
5	Dec. 29	5.00	88.93	75.22	75.14	182.0	2.145	355	19.1	374.0	13.71	391.0	504	644	78.2	78.2	80.5	82.90	
6	Dec. 29	7.50	88.92	75.17	75.12	182.0	3.100	461	23.4	484.4	13.75	565.0	652	650	100.2	70.2	....	74.00	Overgate
7	Dec. 30	5.75	89.57	75.95	75.85	192.5	2.27	422	21.6	443.6	13.62	437.4	597	640	93.3	83.5	85.0	88.10	
8[1]	Dec. 30	4.00	89.42	75.89	75.84	190.1	1.74	252	15.7	267.7	13.53	331.0	362	635	57.0	66.5	70.6	71.30	
9[1]	Dec. 30	6.00	89.37	75.87	75.82	189.3	2.40	431	21.6	452.6	13.50	455.0	611	633	96.5	82.9	84.6	87.50	

[1] Incomplete runs made principally for check on capacity. An approximate determination of efficiency is available by reason of taking flow readings at stations 3 and 6 at elevation 85. From the complete runs a proportion between average velocity over the whole section and the sum of velocities at these two points may be obtained. This proportion serves to determine the approximate velocity for these runs as shown in Col. 10, and from these velocities the efficiencies were determined.
[2] Turbine output horsepower equals kilowatt generator input (Col. 13) converted, plus 3 hp. used in oil pump.

TABLE II. SPEED REGULATION TEST, DEC. 30, LOAD THROWN OFF

Time, Dec. 30	Load Change, Hp.	R.p.m. Normal	Max.	Sec. before Speed Becomes Normal	% Guaranteed	Speed Rise Obtained
11:15	172	89.6	92.5	22	10.0	3.2
11:25	295	89.6	95.0	25	15.5	6.0
11:30	450	90.0	97.5	30	23.0	8.3
11:36	515	89.6	97.5	36	25.0	8.6
11:44	580	89.6	102.0	45	28.0	13.8

detecting immediately any reversal of flow in the measuring section.

The test in general was kept as simple as possible, only the more vital data being taken. These data, together with all the various calculated efficiency results, were tabulated and more in detail than shown in Tables I and II. The column numbers, (1), (4), (6), (7), etc., are retained as on the original sheet to show the omissions necessary here. The missing data cover (2) (3) time beginning and end of run, (5) governor dial, (14) generator horsepower, (15) to (18) generator volts, amperes, field and power factor, (20) head variation, (22) foot-pounds per second turbine input, (23) oil-pump horsepower, (25) foot-pounds per second turbine output,

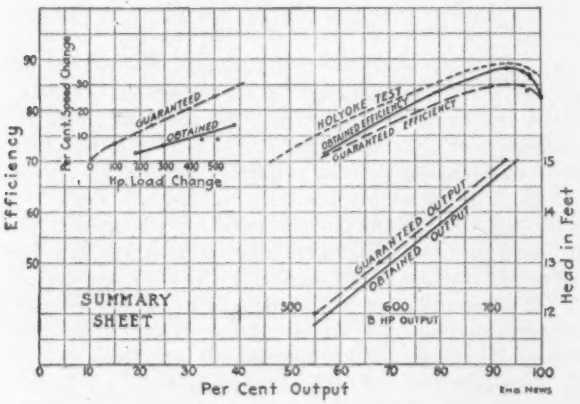


FIG. 6. GRAPHICAL SUMMARY OF TESTS ON GRAND RAPIDS TURBINES

(28) contract horsepower, (29) per cent. excess horsepower, (30) foot-pounds per second plant unit output. In Table II the load change in kilowatts has been omitted and the tachometer readings. Fig. 6 gives the important results in graphical form.

In all of this work a careful record was kept of the actual gate opening in inches in order that a direct comparison with the Holyoke performance might be available. These data greatly assisted the drawing in of the Holyoke curve shown in Fig. 6. It will be noted that a maximum turbine efficiency slightly in excess of 88% was obtained in the power-plant setting. While this efficiency is the highest reported to date on authentic test for a plant of this nature, the inference may be directly drawn that the power-plant setting was not quite so favorable as was the Holyoke setting on a runner of similar characteristics. The difference is undoubtedly traceable to the effect of the more favorable draft tube and to the relatively larger flume at Holyoke. For the plant efficiency overall, considering all turbine and generator losses as well as those in the thrust bearing, governor and governor drive, a maximum of 83.5 was reached. Several of the runs were at "over-gate" points. These were possible by reason of the fact that the gate stops were set back to permit of securing maximum capacity under lower than normal head. The characteristics of the runner are such that the full gate opening is not an over-gate position for heads around 10 and 11 ft., whereas it is very markedly so under heads in excess of normal such as existed during the runs in question.

In making the velocity determinations, the meter readings at the various points were plotted in curve form, these curves being made for both the horizontals and verticals. Fig. 7 shows the vertical velocity curves from which the mean horizontal curve shown at the right of Fig. 8 is drawn. Fig. 8 shows the individual horizontal velocity curves from which mean vertical curve shown at the right of Fig. 7 is drawn. The average velocity was obtained from these curves by means of a planimeter, and the two different determinations checked in all instances well within 1%.

The mean horizontal curve shown at the right of Fig. 8 is of interest as indicating the distribution of velocities across the flume. It will be noted that the turbine is placed concentrically in the flume and that the major portion of the water passes to the left, looking downstream. This is in direct accordance with the theory of spiral flow to a turbine and affords practically a direct indication that the turbine should be placed slightly to the right of the center line of the flume (looking downstream). The turbine rotates in a right-hand direction, and moving it slightly away from the center line tends to provide larger flowage space between the guide vanes and side wall where the flow is indicated as being the greatest. This point probably has very little influence on power-plant performance in an installation of this nature, but the indication is commented upon as having more or less bearing on installations of this type where higher velocities are involved.

Results of the overspeed tests are shown in the following table:

Gate Opening In.	Speed (Field Not Excited) R.p.m.	Speed (Field Excited) R.p.m.
1¾	90.0	....
2	91.5	....
3	105.0	....
4	115.0	....
5	120.0	....
6	126.0	....
7	130.0	....
7½	132.5 (147%)	130.5 (145%)

This overspeed run is of interest as indicating what

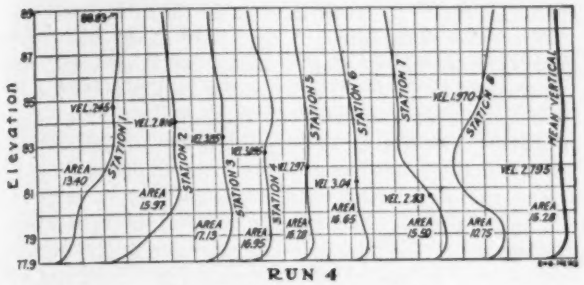


FIG. 7. VERTICAL CURVES

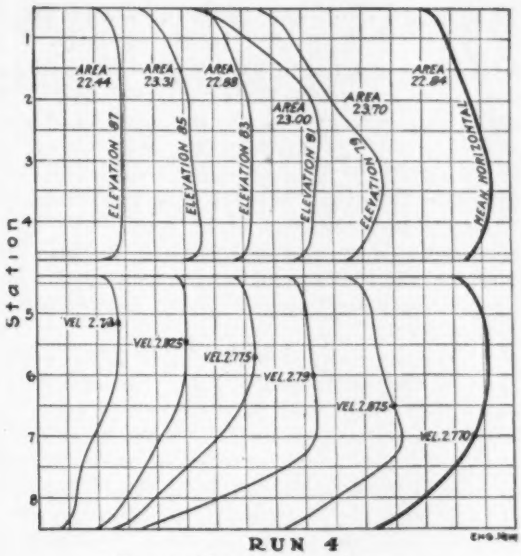


FIG. 8. HORIZONTAL CURVES

VELOCITY CURVES PLOTTED FROM METER READINGS

may be expected in actual installations of this nature. The runaway speed of the runner in the Holyoke flume was between 65 and 70% above normal. The effect of windage and friction is very much in evidence in the reduction of this amount to approximately 50% above. Furthermore, the effect of an excited field was somewhat less than was anticipated, as it only affected the overspeed about 2%.

Prior to and during the tests, the various methods used were discussed and gone over fully with the representatives of the Centralia Pulp & Water Power Co., G. E. Ackerman, of the Jacobson & Ackerman Engineering Co., of Minneapolis, who designed and installed the plant, and E. C. Gleason, of the engineering department of the Nekoosa-Edwards Paper Co. All points of importance were agreed upon as far as possible before the tests proper, and additional points that came up during the runs were taken up and settled to the satisfaction of all concerned. Gardner S. Williams, consulting engineer, Ann Arbor, Mich., was present during the tests by invitation from the Centralia Pulp & Water Power Co., and very kindly volunteered comment and suggestion. The tests were in charge of the writer under direction of W. M. White.

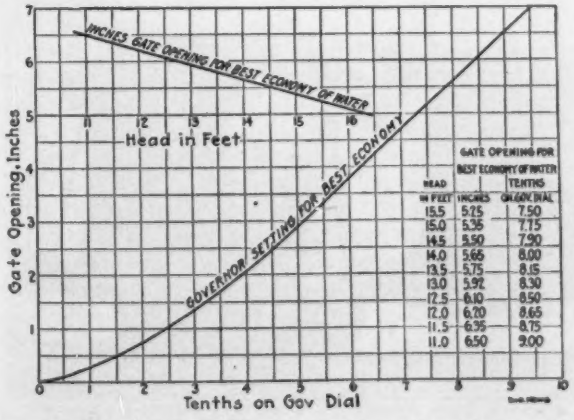

INCHES GATE OPENING FOR BEST ECONOMY OF WATER
Head in Feet
GOVERNOR SETTING FOR BEST ECONOMY
Gate Opening, Inches
Tenths on Gov Dial
GATE OPENING FOR BEST ECONOMY OF WATER
HEAD IN FEET | INCHES | TENTHS ON GOV DIAL
15.5 | 5.25 | 7.50
15.0 | 5.35 | 7.75
14.5 | 5.50 | 7.90
14.0 | 5.65 | 8.00
13.5 | 5.75 | 8.15
13.0 | 5.92 | 8.30
12.5 | 6.10 | 8.50
12.0 | 6.20 | 8.65
11.5 | 6.35 | 8.75
11.0 | 6.50 | 9.00

FIG. 9. CURVE OF MOST ECONOMIC GATE OPENING

At the termination of the tests the head and tail gages were carefully checked over. The check on the tail gage in No. 2 race showed that the gage was slightly off, in such direction and amount that the efficiencies calculated from the test readings should be reduced about ½%. Similar check on the gage in the forebay at the meter section showed a slight error, this being of such amount and direction that the efficiencies as calculated from readings should be increased $\frac{6}{10}$%. It was agreed that the two errors would balance, consequently no account is taken of them. After the tests, the wattmeters were carefully checked and were found to be accurate within $\frac{2}{10}$%. The greatest possibility of error lies in the measurement of the water and in the instrument transformers used for the wattmeters. As regards the former, measurements by the same meter under less favorable conditions of flow have checked within $\frac{4}{10}$% with simultaneous measurements made by a standard Francis weir. As regards the second error, which comes about by reason of the fact that the wattmeters were not calibrated in connection with the instrument transformers which they were used with, it may be stated that similar calibrations have shown maximum errors of about ½%.

Taking into account the above limitations and allowing for the fact that some inaccuracies may counterbalance others, it is believed that the major runs of the tests are accurate within less than 1%.

While the primary purposes of the test work were fulfilled in showing that the machinery exceeded the guarantees of performance, two additional features were of even greater interest. One of these items is of interest to engineers in general and has to do with the extent to which Holyoke test results on model runners may be taken to apply to a power-house setting. Analysis of the Holyoke test sheet as shown in the upper curve of Fig. 6 shows only slight but varying discrepancies in efficiency which are directly traceable to the limits of flume and draft tube.

The other item is of greatest value in connection with future operation of the plant. The record kept of actual gate opening as well as governor-dial reading made pos-

sible an analysis of power-house performance of the units under varying heads. In the operation of the plant more or less head fluctuation will always be experienced on account of the variation of flow of the river, which may be increased by the operation of plants upstream from this development, and because the pondage is limited. As the maximum output is desired at all times, it becomes of vital importance to operate the units to best advantage at all heads. Fig. 9 was based directly on the test data taken in the plant and at Holyoke, and shows graphically and in tabular form the approximate gate opening giving most economical performance at all heads.

The importance of test work of this nature and its influence on improvements in design are beginning to be more fully appreciated by plant owners as well as by engineers and manufacturers. When it is considered that the entire cost of the test work described above was under $500, it is evident that the expense involved is slight in comparison with the value of the information obtained, and practically negligible as contrasted to the entire cost of the development.

If test work of this nature is planned in connection with the initial design of the plant, it frequently occurs that various features tending to simplify the testing may be incorporated at practically no extra expense and not materially affect the commercial operation of the plant. It is hoped that this description in detailing the simplicity of method and low expense involved in carrying out typical work of this nature will serve to further encourage the increasing tendency toward carefully conducted power-house tests.

A Novel Portable Substation for the Berkshire Street Ry.*

The familiar advantages of a railway substation on wheels (insurance of continuity of power at low cost, elimination of idle reserve equipment, quick aid for disabled or temporarily overloaded sections, etc.) have been combined with the benefits of the now popular outdoor-type substation (greater safety of high-tension apparatus and elimination of inclosing structures) by the Berkshire Street Ry., of Pittsfield, Mass., in the car shown by the accompanying illustration.

This portable substation consists of an inclosed operating compartment containing the rotary converter, the switchboard and the electric heaters; an inclosed central room for the lightning arresters; and an open section for the main transformer, the current transformer, automatic oil switches, choke coils, disconnecting knife switches, etc.

The car is all of steel, even to the flooring (¼-in. sheet). At the open end, four vertical and four upper channels form a cross-frame for the disconnecting switches and choke coils. A steel snow-shield frame extends from the cross-frame to a wood block on top of the transformer to protect the horizontal high-tension transformer bushings (brought out thus on account of low clearance). A similar cover protects the incoming-line leads and the connections to the arrester compartment.

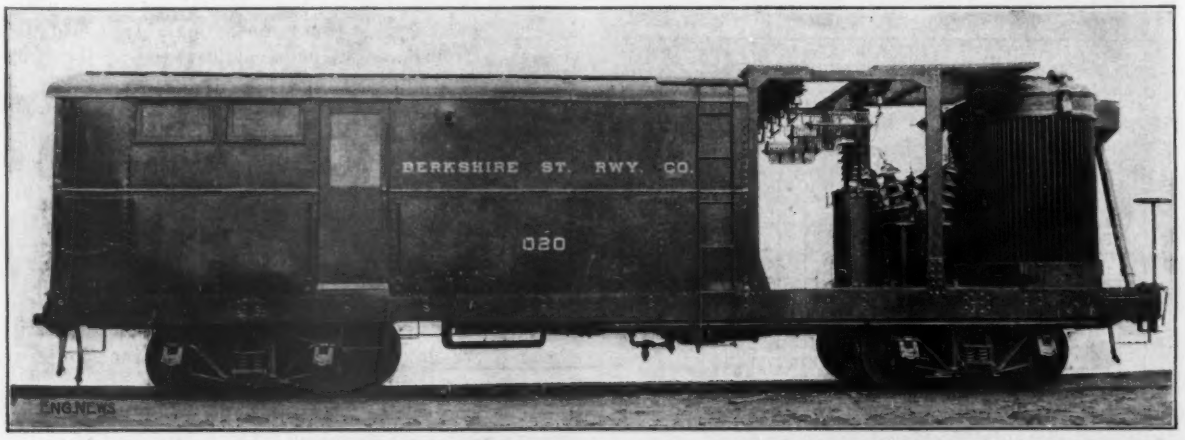
The operating-compartment inclosure may be entirely removed for the installation or removal of apparatus. The section of the roof over the converter is also bolted down so that it may be readily removed for installing or dismantling the apparatus when a crane is available. A galvanized-sheet-metal ceiling is built on the interior so as to form air pockets between it and the roof sheathing to prevent any direct radiation of heat when the car is standing in the sun and also to drain any condensation or possible leakage away from the apparatus. There are two doors into the converter room, a third between the converter and arrester rooms and one from the latter to the outdoor section.

The trucks have 33-in. wheels and are designed to take a curve of 40° radius. The car conforms to M.C.B. standards throughout for passage over steam-railroad lines. The converter is a three-phase 25-cycle 600-volt 750-r.p.m. synchronous type, with commutating poles. The normal rating is for 300 kw. continuously, 450 kw. for two hours and 900 kw. momentarily.

The important data and dimensions are as follows:

Length overall	38 ft.
Width over sides of car	8 ft. 4 in.
Maximum width (over side channels)	8 ft. 6 in.
Height overall (including running board)	11 ft. 6 in.
Height of floor above rails	3 ft. 8½ in.
Total length of inclosed cab	23 ft. 6 in.
Length of converter or operating room	14 ft. 6 in.
Length of lightning-arrester compartment	9 ft.
Length of outdoor section	14 ft. 6 in.
Truck base	25 ft.
Wheel base	5 ft. 2 in.
Wheels	33 in.
Track gage, standard	4 ft. 8½ in.
Total weight	80,000 lb.

*From information furnished by the makers of the car described, the General Electric Co., Schenectady, N. Y.



PORTABLE SUBSTATION OF THE BERKSHIRE STREET RY., PITTSFIELD, MASS.

Location and Construction of Highways in Mountain Country

By F. W. Harris*

SYNOPSIS—This article deals with pioneer road building and road improving—in newly settled countries—when the problem is to get as many miles of good passable highway as possible for a fixed appropriation. The current practice of insisting on a maximum grade of 5% is deprecated and many of its fallacies shown. The construction of mountain highways requires especially light equipment and this requires special methods and implements. The author describes the very successful use of a Bagley dragline scraper on work under his supervision in Washington.

The object of this article is to deal with that type of highway location and construction where the end sought is "all the mileage that the money will build." This is based on the idea that in a new country two miles of good road is better than one mile constructed like a boulevard.

In the far West our problem is not building a particular section of road for a thousand years, but rather building a passable road and allowing posterity the next thousand years in which to improve the road when improvement is justified. By anticipating the wants of our grandchildren we only place such a heavy burden of taxation upon the present generation that *bona fide* efforts for road improvement are discouraged.

All highways are now designed for motor-driven vehicles and these are yearly increasing in efficiency. Observations by the writer show that light cars are a success on roads full of deep ruts and boulders. The light and so called under-powered cars are often given as one of the reasons for establishing a low rate of grade on highways, when in practice such cars have little trouble in ascending 15% grades even on badly surfaced roads.

*Recently Locating Engineer, Washington State Highway Commission, Renton, Wash.

Maximum Grades—Grade is not an object with the heavier type of motor vehicle; suitable surfacing is the most essential requirement. Automobiles of every description travel up 10 and 15% grades in the City of Seattle, Wash. Loaded motor trucks are daily ascending a 12% grade on a country road in the vicinity of Renton, Wash., and this rate of grade is a very common one in the hill country of western Washington.

Trunk-line highways through the mountains located on grades up to 8% will give a much better alignment in nearly every instance than the customary 5% limit now in vogue in this section of the country.

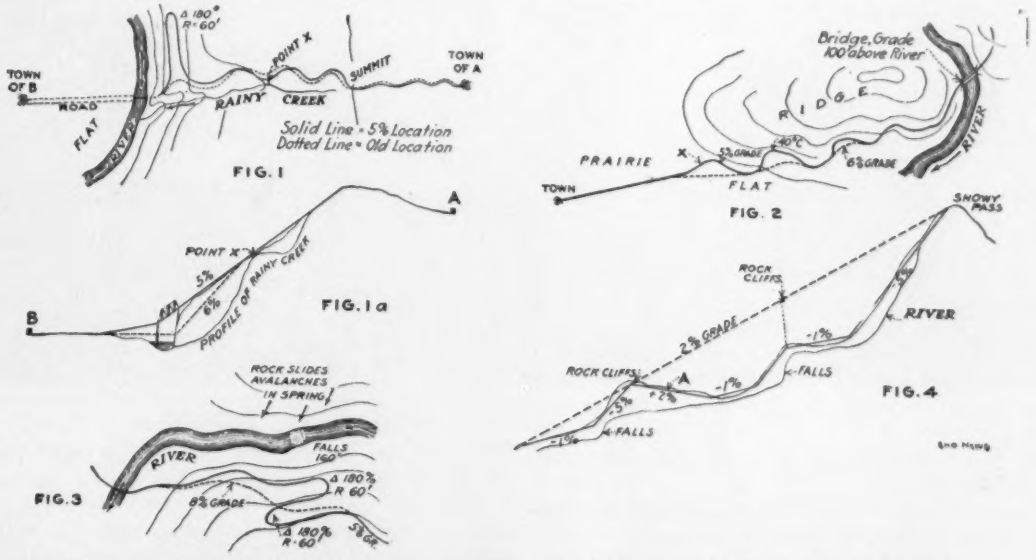
Alignment—Probably half the automobile accidents are due to curvature, and their prevention must be in good alignment, grades receiving secondary consideration. We cannot make our mountain roads fool-proof, but the careful tourist, unfamiliar with the road, is entitled to a chance to dodge the speed lunatics who drive through the hills at 30 mi. per hr.

Where the P. C. and P. T. are visible through the long chord of the curve, any degree of curve up to 40° is allowable. Curvature in cuts and around projecting bluffs should be kept down to a limit of 30°, even if the cost of construction is increased at such points.

A farmer or teamster would rather pull up a mile of 8% grade on a good alignment than a mile and a half of curves on a 5% grade, with a possible surprise party awaiting him at every turn of the road.

Examples of Uneconomical Location—The following are a few typical cases taken from located lines. In Fig. 1 the old road is dotted and is on a varying grade of 6% and 7%. The new road is located on a 5% grade. The loop shown was necessary to develop down to the bridge site, for the other side of the river was flat.

The alignment was not the worst feature, however, for



Figs. 1-4. Examples of Uneconomical Highway Location in Mountain Country

at the point x the road was almost in the creek, and at the bottom of a narrow ravine, where in November conditions bade fair to rival the Grand Canal. Had a 5% grade been used at point x, and a thousand feet of slack grade used there, thence descending on a maximum 6% grade, the loop would have been eliminated and the quantities on the trestle approach to the bridge across the flat would have been cut in half.

In Fig. 2 the elevation at the bridge site was fixed and the ridge across was followed down to the flat. The heavy curvature was used to develop distance as the support ended at x. Here one-half mile of 6% grade on the ridge would have eliminated 180° of central angle and two 40° curves.

Fig. 3 shows a double-loop development on a steep mountain side to maintain a 5% grade. The development is roughly 3 miles in length. Two miles of 8% would have cut out the loops. One fall of 160 ft. in the river shows how steep the descent is.

To cut out the loops a line was run on the other side of the river, but this was only jumping from the frying pan into the fire, for that side was bare and rock slides and avalanches came down in the months of March and April.

Fig. 4 shows an approach to a typical mountain pass. By breaking grade and following the benches, the cheapest and straightest line is secured. Frequently these benches ascend in elevation and an adverse grade at point A is used. It is better to use an adverse grade than to continue on a straight descending grade and develop around those points. Adverse grades should be frequently used to secure a tangent on the ground. It will be found rarely necessary to exceed rising 20 ft. above the original surface under such conditions. Grade should be broken every 300 or 400 ft. if necessary.

One of the great advantages of a broken grade with an 8% maximum is that it enables the locating engineer to dodge costly construction work such as rock cliffs, bad slides and swamps. A road surveyed on a 2% maximum grade in Fig. 4 would allow the locating engineer no opportunity to avoid costly construction.

Even in the roughest mountain country half the highway will probably have less than 3% grades.

Surveys—Contours every 5 ft., if taken carefully 100 ft. each side of the center line, will make a good map for projecting the highway line, if the preliminary line is in about the right place. Such a map will bear the most careful study, as with the use of broken and adverse grades, tangents of ½ to 1 mile in length can be located in the heart of the mountains.

All P. I.'s should be run out and curves should be offset from tangents. This saves time and results in greater accuracy. As curves seldom exceed 400 ft. in length, this is easily done. The levelman in heavily timbered country can obtain levels on the curve stakes with a hand level, if necessary.

Construction

Right-of-Way—Main trunk-line highways through the mountains should have a width of 100 ft. to take care of slopes, especially where right-of-way can be acquired for a nominal sum. This provides for future improvements without the necessity of acquiring a new strip of right-of-way.

Slope Walls—Dry-laid slope walls are a great aid in maintaining alignment on heavy rock work, as it is not necessary to make the rock cuts so heavy owing to the saving on embankment quantities by the use of walls. The thickness of a slope wall at the bottom should be 0.6 of the height; the batter, 0.3 ft. to 1 ft.; the thickness at the top, 1½ to 2 ft., and large stones should be set on top of the wall to serve as a guard-rail. The cost is from 70c. to $1.50 per cu.yd. Italians make good wall builders.

Station Work—The season for mountain-road construction is generally short—not over six months. As a rule this work has to be done by station men, and it is generally best to let the work to this class of labor. To that end the work should be made attractive to the station man by keeping the haul down to 200 ft. Work which has short hauls, even with light scratch cuts, is easily let when good work which involves a haul of 600 to 800 ft. goes begging.

Construction Equipment—It is always a hard matter to get supplies into a mountain country, so that equipment has to be of light weight, such as picks, shovels, mattocks and wooden wheelbarrows, drill steel and dynamite. This becomes more important where pack-horse trails lead to the work, for then there is no opportunity of hauling material at reasonable cost.

Minimum Fills—In heavily timbered country, where consistent with drainage, the grade should be laid with an average of 2 ft. in cut. This will place the road on as good a foundation as the country affords. Shallow fills of 1 and 2 ft. should be avoided, as any number of inspectors could not watch station men close enough to keep them from making a shoddy fill. For drainage 0.5% should be considered a minimum grade.

Drainage—On heavy grades exceeding 3% in sand, clay and earth cuts, the side ditches should be filled with 1 to 2 ft. of gravel or small rocks to prevent scouring and undermining the slope. This protection should be done when the finishing stakes are set, as it only requires about one day's heavy rain to ruin the toe of the slope in the ditch.

Culverts—Timber culverts should be used on new work, as waiting for concrete pipes delays the work. All ordinary timber culverts last ten years and cedar culverts from 20 to 50 years. By the time the culverts are ready to be renewed, a better idea of the drainage of the country is obtainable and facilities for hauling cement are far cheaper.

Grading and Excavation—It is not advisable to attempt too much refinement in balancing quantities. Excavation should run about 1½ cu.yd. to 1 cu.yd. of embankment.

In timbered country 10% of the total excavation can be considered as worthless, as it consists of humus, rotten logs, roots, etc. Another 10% should be deducted for quantities lost in blasting stumps. These percentages to be increased to 15% in each instance where excavation averages less than a 3-ft. cut. These percentages also vary with the locality. In the Bitter Root Mountains in Idaho they would be about 5% in each case. On the western slopes of the Cascades on the Washington and British Columbia coast 15% would not be too high.

Road Building Machinery—A great many attempts have been made to use machinery on mountain roads, but these have generally ended in failure. The most success-

ful machine in use that I know of is the Bagley scraper* and a logging donkey engine.

The donkey is first used to clear the right-of-way of logs, stumps, etc., and when this is done the scraper is attached to the same line. The accompanying illustrations show the manner in which this is done.

To work these scrapers successfully their limitations must be recognized. They are useless in mucking out solid rock. They handle all kinds of loose earth, gravel and boulders containing from 1 cu.ft. to ½ cu.yd. The material must be loose. When conditions are favorable they handle from 500 to 1000 cu.yd. per 10-hr. day.

A Bagley scraper can under favorable conditions handle excavation at 7c. per cu.yd., wherever a large fill is to be made with a short haul and the material is sandy or gravel. On general road work where time is lost in moving up, splicing lines, removing large boulders, etc., the average cost for handling material is from 15 to 20c. per cu.yd., to which must be added from 3 to 5c. per cu.yd. for finishing, as the scraper leaves the work in rough shape.

BAGLEY SCRAPER ON MOUNTAIN ROAD CONSTRUCTION IN WASHINGTON

On the particular work shown in the illustrations two Bagley scrapers were in use, each having a capacity of 2½ cu.yd. One donkey engine was 11x13 in. in size; the other 10¼x10½ in. The advantage of the large size is that there are no delays waiting for steam pressure. The wire cables had the following dimensions: Main line, 1⅜ in. in diameter; haulback, ⅞ in.

COST DATA—The crew consisted of:

Foreman	$6.00 per 10-hr. day	
Engineer	3.50	
Fireman	2.75	
Hook tender	4.50	
Pump man	3.00	
2 rigging men, $3	6.00	
		$25.75
1 team hauling fuel, or		
2 men cutting fuel on right-of-way		6.00
Fuel		10.00
Use of donkey, including depreciation of lines, etc.		10.00
Finishing gang—		
2 teams and teamsters, $6		12.00
4 laborers, $2.50		10.00
		$73.75

Assuming 400 cu.yd. for an average day's work the cost was 18½c. per cu.yd.

Where this output is cut down by encountering large boulders and rock ledges, the classification of excavation as rock offsets the decreased yardage to a slight extent. Changing the classification is not much help, as the scraper is only a money maker in good digging. Its use requires a very competent foreman and a first-class crew to handle the lines; a green outfit could not earn their board.

With plenty of fuel and water, with a short haul for the material not exceeding 400 ft., the scraper should average at least 400 cu.yd. per day.

The steam shovel is not adapted to mountain work, as it cannot pull itself around the way a donkey engine can, and the handling of cars on 5% grades is both difficult and dangerous. If it is impossible to avoid bad slides or swamps, these can be handled with a scraper at a minimum expense. The donkey-engine boiler can also be equipped with an oil burner to still further cut down haulage.

In light earth and gravel cuts a 2½-cu.yd. scraper will push another ½ cu.yd. of material ahead with a 200-ft. haul; it can easily move 1000 cu.yd. in ten hours. It may not be amiss to add that the scrapers do efficient work on channel changes and in loading gravel into bunkers from river beds. In channel change work the hitch should be placed so that the scraper is pulled upstream.

GRADE STAKES—The draglines tear out all slope stakes the first thing. The best system for referencing is to mark a tree as nearly opposite the stake as possible, or drive a heavy stake with the two cuts or fills marked on it and also a distance to the center line; thus,

C 4.0 C 8.0 Center 42.4 C 12.0

The last cut of 12.0 is an H. I. for getting grade; 42.4 is distance to the stake on the center line.

The road foreman sets off these reference distances using a hand level and a 16-ft. rod with the feet and five-tenths marked. At every foot is a small hook and to it is attached the ring at the end of a 50-ft. steel tape. The hook tender acts as rodman so that there is no waiting for the engineer to give grade. The engineer follows behind the donkey setting grades for the finishing gang.

With a crew that understands keeping their lines and grades, good progress can be made where, if they had to stop and wait for an engineer to give grade, the construction crew would be idle half the time.

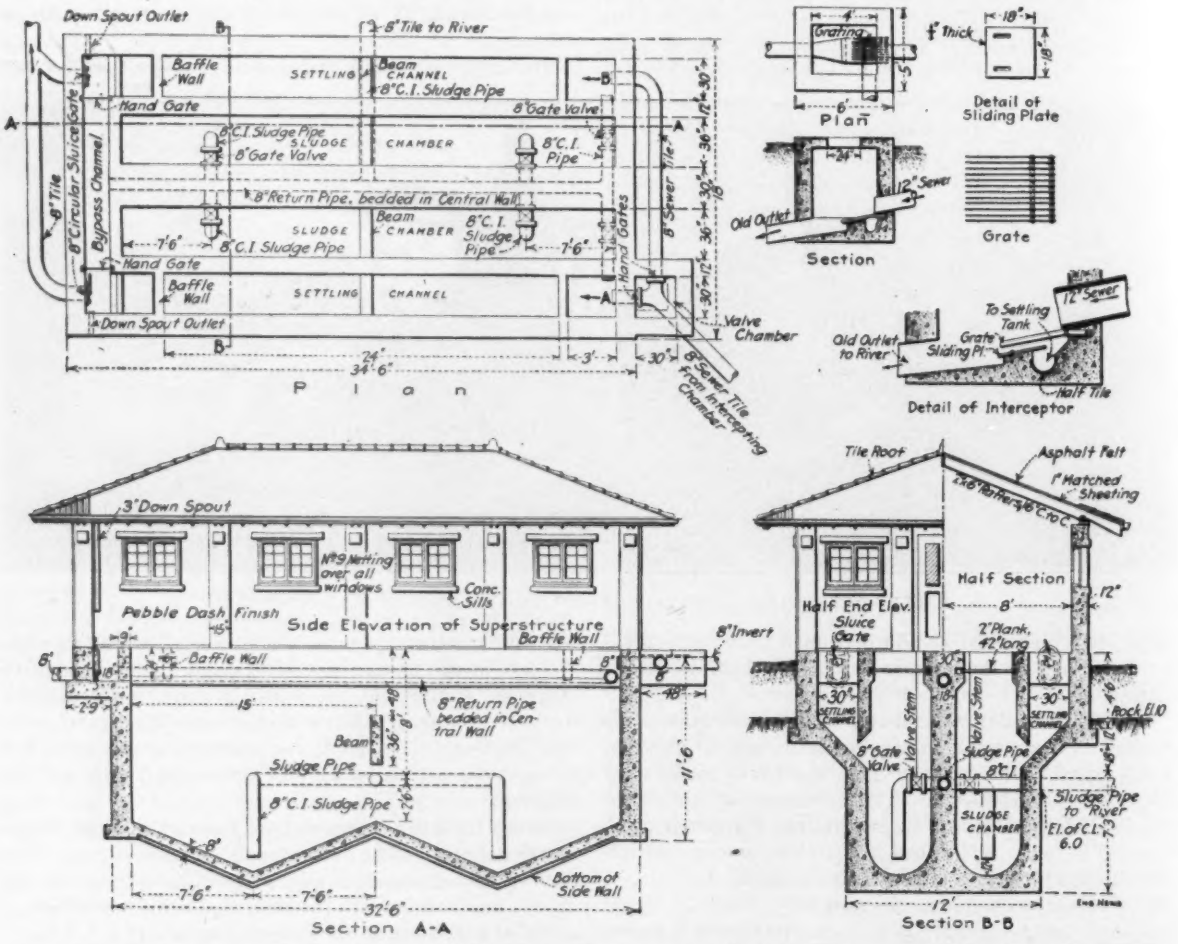
*Described in "Engineering News," Feb. 1, 1906, Mar. 21, 1907.

Sewage-Intercepting Chamber and Settling Tank for a Public Institution at Geneva, Ill.

At the Illinois State Training School for Girls, at Geneva, Ill., there are two sewage-settling tanks serving different sections of the institution, with capacity to take care of the sewage from a population of 600 and 400 respectively. The accompanying drawings represent the larger plant. At present the tank effluent is discharged directly into the Fox River, but some further treatment of the effluent may be required later. The tank is built close to the river bank and about 1000 ft. from the buildings which it serves, but is not visible from the buildings.

ing the amount of flow to be caught by the trough of the interceptor.

The tank, as shown by the plan and sections, has two settling channels and two sludge chambers. These, normally, are to be operated in series, and with the direction of flow alternating in opposite directions, thus insuring an even distribution of the sludge. Thus the sewage at *A* flows through the first settling channel to the by-pass channel and then through an 8-in. return pipe in the central wall to the head of the second channel at *B*. From the lower end of this channel it enters the outlet pipe to the river. By adjusting the gates, the sewage may enter first at *B*, flowing to the by-pass channel and return pipe, and entering the second channel at *A*. If



SEWAGE-INTERCEPTING CHAMBER AND SETTLING TANK AT THE ILLINOIS TRAINING SCHOOL FOR GIRLS, GENEVA, ILL.

Originally the sewage was discharged at the east bank of the river through an outlet sewer. This sewer is now fitted with an intercepting chamber 3x4 ft., constructed as shown in the accompanying details. The ordinary sewage flow falls through a grating into a trough leading to an 8-in. tile pipe to the treating plant. Stones or other large objects are caught by the grating and carried forward to the old outlet. The main sewer from the institution receives the roof water, and any heavy stream of storm water shoots across the trough to the old outlet sewer. An adjustable sliding plate provides for regulat-

necessary, either channel can be operated independently, the sewage entering at the upper end and the effluent discharging into the outlet pipe at the lower end. The flow line in the channels is about 13 ft. above normal water level in the river. The rate of flow in the settling channels is about 40,000 gal. per day.

The unusual form of the channels and sludge chambers is designed to give ample capacity and to prevent the flow in the channel from interfering with or disturbing the sludge as it settles in the upper part of the chamber. In the longitudinal direction, the chamber forms

two settling hoppers, into each of which depends the vertical end of the 8-in. sludge pipe. The sludge pipes unite in an 8-in. discharge which extends to the river.

The tank is of concrete, in proportions of 1:2:4. The water surfaces are given a smooth dense finish by waterproofing. The tank is covered by a concrete building with a stucco finish and a red tile roof.

Both of the tanks at the school were designed by the W. S. Shields Co., consulting engineers, of Chicago, and are now being built by the Nash-Dowdle Co., also of Chicago. The contract price of the two plants complete, including the intercepting chambers and the river outlets, which are short, was about $5800.

An Ambulance Train on an English Railway

In no previous war in the world's history have such measures been taken for the rescue and care of the wounded as are now being adopted in Europe. In all the countries now engaged in war, special trains have been fitted up for the transport of those of the wounded able to bear the journey from the field hospitals at the front to permanent hospitals in cities far removed from the scene of action.

INTERIOR OF A HOSPITAL CAR ON THE GREAT EASTERN RY. OF ENGLAND

The accompanying view shows the interior of one of the cars of an ambulance train on the Great Eastern Ry. of England. It might be thought that the English compartment cars, with side corridor, would be better adapted for hospital purposes than the American type of car with its central passageway. The latter, however, has the great advantage of providing a much larger amount of accommodation in a given space.

To adapt the English car to its new use, therefore, the compartment partitions were removed and all the side doors were permanently fastened, except one pair at the end of the car formerly used by the guard and luggage. Wooden studs were then fastened to the car sides and to these were secured two tiers of hinged metal berths arranged to fold up against the sides of the car when not in use. The lower berth has its outer edge supported by legs extending to the floor and the upper berth by inclined struts running back to the side of the car. The limitations of English rolling stock make this arrangement less roomy than would be possible on an American railway. In the car illustrated, the clear width inside is 8 ft. 9 in., and the berths are 2 ft. 6 in. wide.

Besides the cars made up with berths in this way, other cars of this hospital train contain accommodations for the surgeons and nurses to attend the wounded. There is a kitchen car for the preparation of food, compartments containing medical and surgical supplies, an office for the chief surgeon in charge of the train and an operating room.

Bacteriological Standards for Drinking Water Supplied in Interstate Commerce

Bacteriological standards of purity for drinking water supplied to the public by interstate common carriers were promulgated on Oct. 21, 1914, by W. G. McAdoo, Secretary of the Treasury (acting in behalf of the U. S. Public Health Service), as follows:

The following are the maximum limits of permissible bacteriological impurity:

1. The total number of bacteria developing on standard agar plates, incubated 24 hr. at 37° C., shall not exceed 100 per c.c. Provided, that the estimate shall be made from not less than two plates, showing such numbers and distribution of colonies as to indicate that the estimate is reliable and accurate.

2. Not more than one out of five 10-c.c. portions of any sample examined shall show the presence of organisms of the bacillus coli group when tested as follows. [Technical details omitted here.—Editor.]

3. It is recommended, as a routine procedure, that in addition to five 10-c.c. portions, one 1-c.c. portion and one 0.1-c.c. portion of each sample examined be planted in a lactose peptone broth fermentation tube, in order to demonstrate more fully the extent of pollution in grossly polluted samples.

4. It is recommended that in the above-designated tests the culture media and methods used shall be in accordance with the specifications of the committee on standard methods of water analysis of the American Public Health Association, as set forth in "Standard Methods of Water Analysis" (A. P. H. A., 1912).

The standard given is one recommended by a commission of 15 chemists, biologists and sanitarians appointed by Secretary McAdoo on Jan. 22, 1914.*

In concluding its "progress report," the commission states:

In submitting the recommendations herewith presented it may be again emphasized that the limits defined are recommended with reference solely to the special object of the control of the supplies of common carriers, having in mind that these supplies constitute a special case because of the following reasons:

1. The supplies come from widely diversified and mixed sources.

2. Samples taken from common carriers represent waters stored for various lengths of time under varying conditions.

3. In view of the impossibility of accurately ascertaining the source and history of each supply examined reliance must be placed upon the results of laboratory examination to a greater extent than is necessary or justified in estimating the quality of a supply from a known source with a known history.

It is requested that the recommendation of these hard-and-fast limits of bacteriological impurity be not interpreted as

*The names of the members of the commission, a "progress report outlining the problem which confronted the commission, and fuller technical details for determining the standards are printed on pp. 2959 to 2966 of "Public Health Reports" (Washington, D. C.) for Nov. 6, 1914. The chairman of the commission is John F. Anderson, Director Hygienic Laboratory, U. S. Public Health Service, Washington, D. C.

minimizing in any way the importance of field surveys in estimating the sanitary quality of water-supplies in general. It is always desirable to obtain information from as many angles as possible, and this is, indeed, necessary in order to form an altogether fair estimate of an individual supply.

Pending the preparation of the report recommending specific limits for permissible chemical impurities, it is recommended that water-supplies which may be bacteriologically sanitary be excluded from use when, in the opinion of the Surgeon General, they are definitely injurious to health or grossly offensive by reason of chemical impurities or physical properties.

Use and Tests of Unscreened Gravel: Illinois State Highway Department

By Clifford Older*

For a number of years the Illinois Highway Department has admitted the use of unscreened or pit-run gravel for concrete in the building of highway bridges.

The specifications provide that such gravel be of standard quality and that cement be proportional to the sand

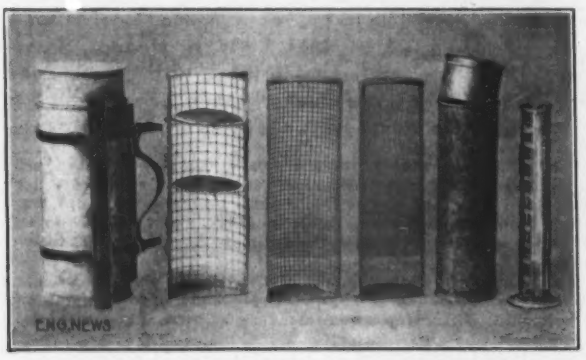


Fig. 1. Gravel-Testing Outfit Used by the Illinois State Highway Department

contained in the gravel. For instance, "Class A" gravel concrete must contain 1 part of cement to each 2½ parts of sand, while the stone may vary from a maximum of 4 parts to 0. This means that the resulting concrete may vary from the equivalent of a 1 : 2½ : 4 mixture to a 1 : 2½ : 0 mixture. Sand is defined as that portion of the gravel which will pass a ¼-in. screen.

Results of many compression tests indicate that concrete increases in strength as the proportion of stone decreases. Therefore, with competent inspection there is no reason why concrete of satisfactory strength cannot be obtained by using unscreened gravel.

On large work, and in many cases on comparatively small work, it is more economical to screen the gravel or add coarse aggregate, in order that the minimum amount of cement may be used. Nevertheless, on small and scattered work, it is often cheaper to use the natural material with the necessary increase in the amount of cement.

A bank of gravel may contain strata differing widely in granulametric composition, and yet the gravel from such pits, when delivered at the bridge site, frequently shows not more than 3% variation in sand content. The various strata become more or less mixed by the caving of the bank and in the process of loading and dumping from wagons or cars.

*Bridge Engineer, Illinois State Highway Department, Springfield, Ill.

It is somewhat unusual in testing a carload of unscreened gravel to find a total variation of more than 5% in the sand content. It is not unusual to find as great a variation as this in aggregate artificially proportioned by methods in common use.

Gravel Tester

In order to facilitate making tests of unscreened gravel, the writer devised the testing outfit shown in the illustration, Fig. 1.

At the left is shown the testing can, which is provided with a close-fitting telescopic cover. The testing can serves also as a convenient carrying case when provided with a shawl strap as shown.

The various articles to the right nest one within the other from right to left and fit in the main receptacle or testing can. There is room also to pack the inspector's hand level, a 50-ft. steel tape, a 5-ft. folding rule, and, if not too bulky, a set of bridge plans. Fig. 1 shows only the articles used in testing. All of the articles except the scale and the 200-c.c. glass graduate are made of galvanized iron.

The testing can is 4 in. in diameter and without the cover is exactly 10 in. deep inside. The scale is 10 in. long and is graduated to inches and tenths.

The screens used by the Illinois Highway Department have ½-, ¼- and ⅛-in. square openings. The ¼-in. screen is used to determine the ratio of sand to gravel. The ⅛-in. and ½-in. screens are used to check the gradation of the sand and stone respectively. Obviously, any other set of screens may be substituted if desired.

The can of small diameter is used as a protector in which to pack the glass graduate and for washing sand in making the clay test. The 200-c.c. graduate is used for measuring volumes of sand and sediment in the water-settlement test for clay.

Testing Gravel

In testing the sand for clay, 200 c.c. of sand screened from the gravel are measured by means of the graduate

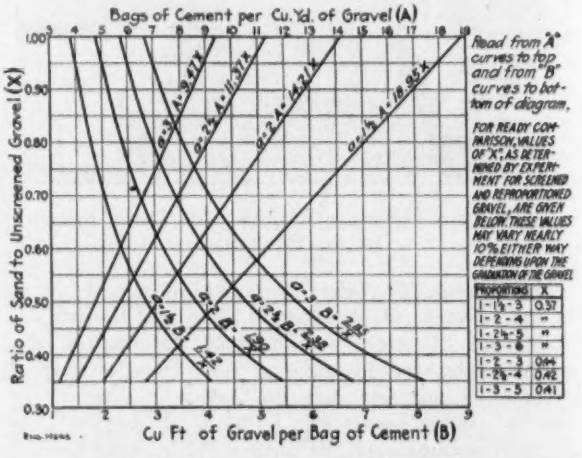

Bags of Cement per Cu. Yd. of Gravel (A)
Ratio of Sand to Unscreened Gravel (X)
Cu Ft of Gravel per Bag of Cement (B)
Read from "A" curves to top and from "B" curves to bottom of diagram.
FOR READY COMPARISON, VALUES OF "X" AS DETERMINED BY EXPERIMENT FOR SCREENED AND REPROPORTIONED GRAVEL, ARE GIVEN BELOW. THESE VALUES MAY VARY NEARLY 10% EITHER WAY DEPENDING UPON THE GRADATION OF THE GRAVEL
PROPORTIONS X
1-1½-3 0.57
1-2-4 "
1-2½-5 "
1-3-6 "
1-2-3 0.44
1-2½-4 0.42
1-3-5 0.41

Fig. 2. Diagram for Use in Proportioning Cement to Unscreened Gravel

and poured into the smaller galvanized tube. The sand is then washed repeatedly with clean water until the water comes off clear. The wash water is poured into the gravel can and allowed to settle. When clear, the water is drawn down to about 200 c.c., which should contain all the mud.

This is poured into the graduate and at the end of three hours, the depth of sediment is read. The reading divided by two equals the percentage of clay.

The results obtained by the water-settlement test (three hours' time) have been found, by a large number of determinations, to be from two and one-half to three times as great as those obtained by dry volume or weight tests. The ratio of the settled volume to dry volume is not constant, but varies with the character of the sediment. If, therefore, the water-settlement test shows between two and one-half and three times the allowed dry volume, the test should be confirmed by a dry volume or weight determination.

It has been found that volumetric determinations of the percentage of dry clay correspond very closely with weight determinations. The water-settlement test is very simple and the only practical one for field use.

A graduate having an internal diameter of about 1 in. is recommended, as the readings may more accurately be made than in tubes of greater diameter.

Washing with repeated changes of water is essential, as all of the sediment is separated. Merely shaking 2 or 3 in. of sand in the tube with clear water and allowing the whole to settle leads to error; first, because of the sediment in the muddy water contained in the voids of the sand; second, there is no check on the thoroughness of the washing, and third, the dividing line between the fine grit and clay is not always distinct.

Repeated changes of clean water separate all of the ediment, and, in addition, the number of changes required affords a means of judging the practicability of a thorough washing of the gravel, if washing proves necessary. Sand containing soft grains may also grind up in the process of washing. The necessity of many changes of water may indicate a material which will grind to powder in a mechanical mixer and is therefore unfit for use.

To test a sample of gravel for sand ratio, the testing can is filled level full with the selected sample of gravel, and the sand and stone are separated by the use of the ¼-in. screen. The sand and stone may be caught on newspapers and poured separately in the testing can for measurement. As the can is cylindrical in form and $\frac{1}{16}$ in. represents $^1/_{100}$ of the depth of the can, the reading of the scale, when placed in the can zero end up, represents to the nearest 0.01 the ratio of the volume of sand or stone to the volume of the original gravel.

The amount of sand or stone in any given volume of gravel may be found by applying these ratios. Convenient formulas may be written for determining proportions. The following notation will be used:

x = Ratio of volume of separated sand to volume of unscreened gravel;

y = Ratio of separated stone to unscreened gravel. (For well graded gravel $x + y$ should be from about 1.10 to 1.25);

a = Required ratio of sand to cement;

b = Maximum ratio of stone to sand;

A = Bags of cement required per cubic yard of gravel;

B = Cubic feet of gravel to use with one bag of cement;

C = Amount of stone to add to a unit volume of gravel in order that the minimum amount of cement may be used.

Considering one bag of cement to contain 0.95 cu.ft., the following formulas may be written:

$$A = \frac{27\,x}{0.95\,a} = \frac{28.4\,x}{a}$$

$$B = \frac{0.95\,a}{x}$$

$$C = bx - y$$

The following example illustrates the use of these formulas:

Assume that a batch of gravel tests 0.60 sand, and 0.50 stone, and that the mortar ratio is to be as one of cement to 2½ sand.

$$x = 0.60;\ y = 0.50 \text{ and } a = 2.5$$

$$A = \frac{28.4 \times 0.60}{2.5} = 6.8$$

$$B = \frac{0.95 \times 2.5}{0.60} = 4.0 \text{ (practically)}$$

If it is desired to add stone to the above gravel in such quantity that the proportions may be represented by the formula, 1 cement, 2½ sand, 5 stone, then $b = 2$ and $C = (2 \times 0.60) - 0.50 = 0.70$.

One bag of cement would be used with 4 cu.ft. of gravel and 2.8 cu.ft. of stone.

The diagram, Fig. 2, is plotted from the formulas for A and B, and affords a convenient method of determining the amount of cement required when unscreened gravel is to be used.

Boiling Test of Cement

The gravel tester may conveniently be used for making the accelerated or boiling test of cement in the field. Temporary wire shelves are fixed in the screen of largest diameter. On these shelves are placed the glass plates, which should be cut roughly circular in form. The screen then forms a rack, which with the pats in place may be placed in the testing can. The testing can then serves first as a moist closet and later as a receptacle in which the pats are boiled. Fig. 1 shows the large-mesh screen arranged with two pats in place. Standard methods are used in making the test.

Conclusions

With the outfit described, after a little practice, an inspector can make a sand test in about 70 sec. It is practicable, therefore, particularly on small work, to test every wagon load of gravel before it is dumped and by dumping loads bearing practically the same sand content in separate piles, the proportioning is very simple.

Ordinarily, two or at the most three separate piles will provide means for fully as exact proportioning of cement as is ordinarily secured with screened materials.

Commonly, however, such frequent tests are not necessary, particularly when the gravel is handled a number of times between the pit and the site of the work as in case railroad transportation is required.

Except in making preliminary tests at the pit, for the purpose of determining what the character of the delivered material is likely to be, it is not necessary or desirable to select representative samples and by mixing and quartering endeavor to secure an average sample.

Modifications of the testing outfit and methods of proportioning described have been used by the Illinois Highway Department on bridge work for several years. The results obtained are considered to be entirely satisfactory. The testing outfit is not patented.

The New York Rapid Transit Railway Extensions*

By F. Lavis†

X--Tunnels in City Streets

The Lexington Ave. Tunnels

With the exception of the tunnels under the rivers, referred to in the next article, practically the only parts of the subway lines as now laid out, to be built as true tunnels, are those under Lexington Ave. for the two lower-level tracks from about 53rd St. to 78th St., and for all four tracks from about 91st St. to 102nd St. The total length of these four sections is about 2.6 miles, of which about 2 miles is to be built in tunnel. The tunnels on Sec. 9 are being driven in part by Messrs. Douglas & Shailer, under a subcontract for P. McGovern & Co. The rest are parts of Sec. 8, 10 and 11, and are being built by the Bradley Contracting Co.

No particularly new methods of driving these tunnels or of handling the material have been used, but some features of the work are of interest on account of the difficult and uncertain nature of the rock which has been encountered. This is the typical gneiss or mica schist which underlies the whole of Manhattan, varying from quite hard to very soft and partially disintegrated material, containing many seams and dipping and striking very irregularly, thus tending to cause slips and slides, which the utmost vigilance and care cannot always avoid. Driving a tunnel, therefore, or even making an open cut through this kind of material under a street carrying heavy city traffic, and with important buildings on both sides of it close to the work, requires most careful methods of excavation.

On Sec. 11, the situation is complicated by the change from double-deck two-track tunnels, one over the other, to a four-track section with all the tracks at one level, making a tunnel section of practically rectangular shape 16 ft. high and nearly 60 ft. wide (see Fig. 68-I).

A power plant which supplies air to all four of these sections was established by the Bradley Contracting Co., at 96th St. and the East River. It contains five compressors, each of a rated capacity of about 2100 cu.ft. of free air per min., which is piped through a 10-in. main to all sections, the distance from the power house to the center of the farthest section being about 2½ miles. Comparatively little trouble has been experienced with this line, though, of course, with four separate and fairly large organizations depending on one source for their supply of air, there have been times occasionally when all would be working or attempting to work at full capacity and the pressure would consequently drop.

A supplementary compressor of about 1500-cu.ft. capacity, connected to an electric motor for use in emergencies, has been installed in a part of the completed subway on Sec. 9, at 77th-81st St., but so far it has not actually been used. There has been some trouble on the long main-feed lines with freezing in cold weather, but nothing of importance. The main is carried underneath the decking of the street.

The Bradley Contracting Co. arranged for the hauling and disposal of the muck from Sec. 9, as well as from all its own sections, so the same type of buckets are used throughout all four sections; they are the so called battleships already referred to (in the article on excavation).

In the tunnels, four small power shovels (Marion model 40) were used for handling the muck in as many headings, where there was room for them, but a great deal of the material was handled by hand shoveling. Some experiments were made with other types of mechanical excavators, designed for use in a more limited space than that necessary for the operation of a shovel, but they were not successful enough to warrant their continued use.

The buckets, placed on small four-wheel cars (Fig. 66, lower view), were hauled back and forth between the shafts and the headings by various means, but no mechanical locomotive power was used. Single-drum air hoisting machines were arranged on platforms above the floor of the tunnel to haul the cars up grade, either the loads out of the heading or the empties back as the case might be, the cars being allowed to coast down grade. A single haulage line was used, the end being carried back by hand or by a mule.

Where the rock was good the full section of double track was usually taken out by driving a top center heading about 8 ft. high and 12 ft. wide, keeping the enlargement close up. The heading was pulled by the usual V-shaped center cut, with necessary side rounds, 20 to 40 holes 6 to 8 ft. deep, according to the character of the rock, being required for the whole heading. About 3 lb. of 60% forcite was required per cu.yd. in the headings in hard rock; 40% was used in the softer rock.

In one case a pilot heading was first driven all the way through between two of the shafts to permit better ventilation, especially for the erection of the structure, which it was desired to keep fairly close up to the excavation.

Timbering was required to support the rock in many places, and although segmental timbering was used, the arch was so flat that some center supports were almost always required. The original design for the double-track tunnels provided for a reinforced-concrete center wall, but here as in the use of this class of material in the cut-and-cover sections, where the ground or the street surface required continuous support, it was found to be difficult to make a good job with it. The type of structure shown in Fig. 9 permits the construction of the center wall with the two haunches, as shown in outline, before the rest of the structure is built and permits support on the permanent steel structure at once. The method is shown also in the sketch, Fig. 67, which shows the various steps of construction in the double deck, double-track tunnels on Sec. 11 and also incidentally the enlargement for the upper level local station at 96th St.

Figs. 69 and 70 show typical methods of supporting the timbering and the rock above, where the latter was generally fairly good. The methods used varied in detail in different headings, but in general were more or less

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†Consulting Engineer, 50 Church St., New York City.

ring erected, in the position in which poling boards would usually be driven. These projected forward over the position of the next ring and were blocked up from it after it was erected. This slight variation from the method of placing the lagging provided some protection from small dropping rocks, and was more easily accomplished than driving the poling boards, which would have been difficult in the material excavated.

The general appearance of this timber section is shown in the upper left view in Fig. 66, but in some parts of the work where the ground was particularly heavy, the space between the timber rings was filled with concrete, as soon as possible after they were erected, and the ground overhead was thoroughly grouted. Even then it was necessary to use some temporary supports for the center. Details of two types of timbering used are shown in Figs. 69 and 70.

As is indicated in this latter drawing, the wall plates were sometimes supported on a ledge of rock, but more often were posted down to subgrade when the bench was

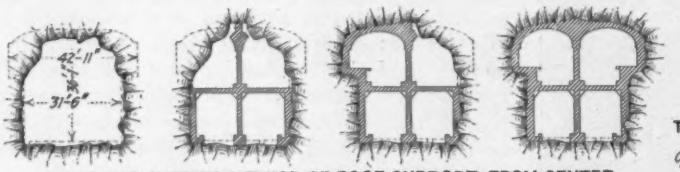
FIG. 66. VIEWS IN LEXINGTON AVE. TUNNEL

Segmental roof timbering (upper). Shovel and car (battleship) for handling muck (lower).

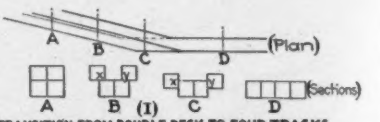
alike. The flatness of the arch will be noted and the supports on either side of the center wall, permitting the construction of this latter and the transference to it of the load, thus permitting the construction of the two arches.

Near the upper end of Sec. 8 and 9, from 56th to 78th St., very soft disintegrated rock, carrying considerable water, was found, necessitating typical soft-ground tunneling methods. Timbered side drifts were driven for the wall plates, segmental timbering tightly lagged was erected from them with about twelve inches between each ring, crown bars and poling boards were used, but the latter were not usually driven, as the rock would hold for a short time. The method actually used was really to place lagging over the top of the arch in the position of poling boards, wedged down at one end, over the last excavated. The raking braces shown were usually only used temporarily to help support the wall plate while the posts were set under in very soft material, but occasionally they were left in.

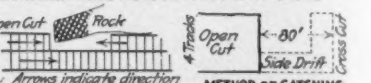
Fig. 71 shows a method of timbering used as part of Sec. 9 south of 78th St., where the rock, while quite hard, required support to prevent slides or the possible movement of large masses. A center top heading was driven and as soon as the enlargement was made, which was kept close up, the timber was erected, as shown in the "first stage" cross-section. In the "second stage" the two pairs of continuous I-beams are placed to span the bench excavation as shown in the longitudinal section in Fig. 70. These I-beams were joined with long splices to develop full strength at the joints and were made continuous throughout the work. The muck from the heading and



DIAGRAMS SHOWING METHOD OF ROOF SUPPORT FROM CENTER PARTITION WALL - SECT. 11 R.5 LEXINGTON AVE.
FIG. 67



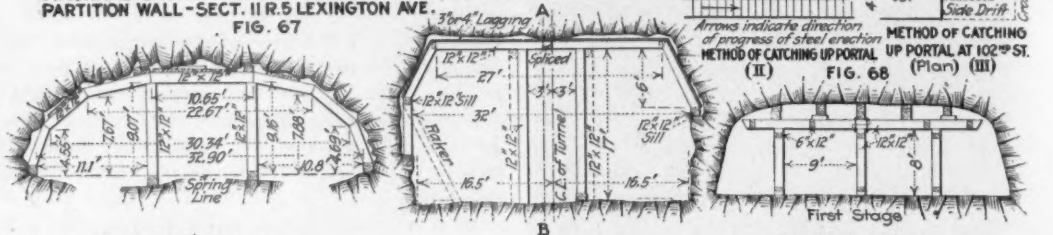
TRANSITION FROM DOUBLE DECK TO FOUR TRACKS



METHOD OF CATCHING UP PORTAL (II)

METHOD OF CATCHING UP PORTAL AT 102ND ST. (Plan) (III)

FIG. 68



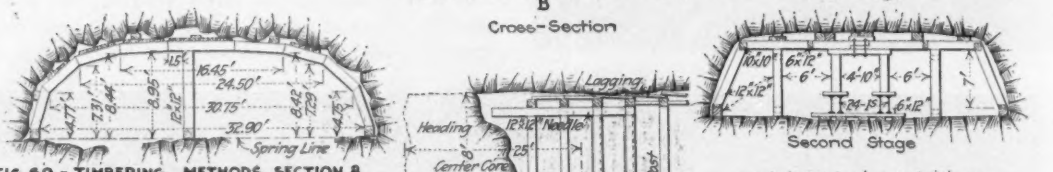


FIG. 69 - TIMBERING METHODS, SECTION 8 LEXINGTON AVE. TUNNEL

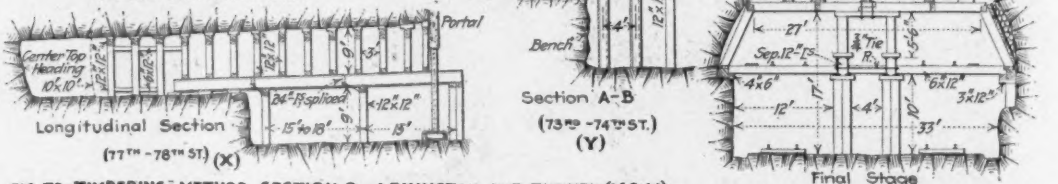
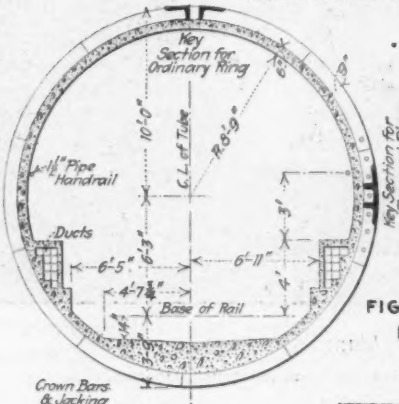


FIG. 70 - TIMBERING METHOD, SECTION 9 - LEXINGTON AVE. TUNNEL (X & Y)

FIG. 71 - SKETCHES SHOWING TIMBERING SUPPORTS ETC. SECT. 9

LEXINGTON AVE. TUNNEL



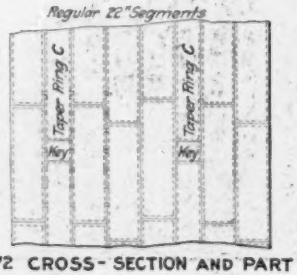
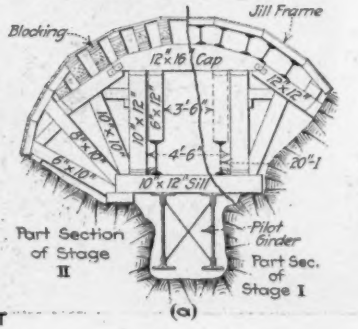
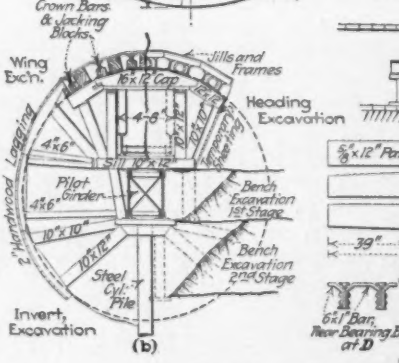
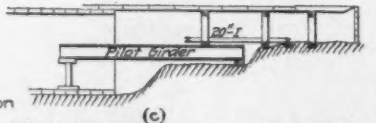
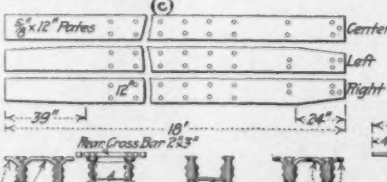


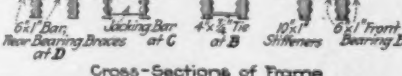
FIG. 72 CROSS-SECTION AND PART ELEVATION OF VESEY STREET CAST-IRON LINED TUNNEL



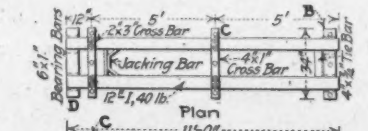


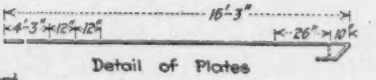






Cross-Sections of Frame





Detail of Plates

(d)

FIG. 74 - SKETCHES SHOWING MEEM'S METHOD OF TUNNELING (a, b, c, d)

VESEY ST. TUNNEL

Eng. News

enlargement was brought out in small buckets on the tracks, laid on the cross-braces at the springing line and dumped into the buckets on the tracks below, at a point back of the face of the bench.

All timber is provided and placed by the contractor at his own expense, the cost being included in the excavation price. The extra excavation necessary to place the timbers outside the lines of the structure is also at the contractor's expense, the payment line being confined to the neat line of the structure. Concrete placed between the timbers, however, is paid for where ordered, as is also the grouting.

At some places a center top heading was driven ahead, then the enlargement was made all on one side just large enough to permit the steel and concrete structure for one track to be built in it, then the further enlargement was made for the second tunnel, the top of the center wall forming the abutment for the arch first erected being necessarily braced to the sides until the second arch was erected. This method obviated the necessity of anything but occasional support of the rock where there appeared to be a tendency to slip.

On Sec. 8 and 9, the cut-and-cover excavation for the upper-level tracks was quite generally completed and the structure erected in it before the tunnel underneath was driven. No damage to the upper structure or difficulty of moment has been experienced due to this method of procedure except in one or two cases, where the extremely heavy rains of last fall, working under the completed upper structure, washed some of the material under it, into the excavation of the tunnel below, the heading of which happened at that time to be in very soft disintegrated rock. The upper tunnel structure at this point was temporarily supported by heavy timbers and girders which spanned the washed-out portion and the latter was then thoroughly grouted and the trouble remedied. Close watch was kept at all times of the upper tunnel at points just above the places where work was being carried on below, and any indications of trouble, as were shown in one or two cases by small cracks, were investigated and the ground below thoroughly grouted if this appeared necessary. The efficiency of this grouting under high pressure was shown in one case where grouting was done from below, the grout being forced up into the upper tunnel.

Just north of 98th St., the two upper tunnels spread out, and as soon as they get far enough apart, drop down to the level of the lower tunnels, until all four are at the same grade, as shown in Fig. 68-I. Working from the shaft at 97th St. toward the north, the two lower tunnels are being driven first and the steel and concrete structure erected in them, then the two upper tunnels are to be driven at the sides. The cross-section *C* will show the necessity of this, as it will easily be seen that the corners *X* and *Y* will probably break through, and the character of the rock is such that it would hardly be possible to hold up the mass between.

At the upper end of this section at 102nd St., working southerly in the four-track section (Fig. 68), the method which has been developed and started is based on the idea of driving one side of the tunnel first for a distance of about 80 ft., then erecting the structure in it, then starting the second tunnel, and so on, thereby avoiding having the excavation open for more than the width of one tunnel at once.

Some difficulty was experienced in catching up some of the portals, a typical method of overcoming it being shown in the sketch, Fig. 68-II. At the beginning of the double-deck tunnel just south of 95th St., the lower level was driven through, the steel structure erected and concreted, then the upper level was worked back from the inside to the portal, as shown.

At the portal at 102nd St., where the four tracks are all at one level, a side drift was driven for a length of almost 80 ft., a crosscut was then made from this drift the full width of the structure, as shown in the sketch, Fig. 68-III, and the structure then erected so that the rock was caught up and then the excavation carried back out to the portal.

Vesey St. Iron-Lined Tunnels

On Sec. 1-A of the Broadway line there is a reversed curve where the route passes from Church St. through Vesey St. to Broadway, and the narrowness of the streets makes it necessary to pass under private property at each of the corners. The material for a considerable depth (50 to 60 ft.) below the streets in this section is sand, but it is comparatively dry down to the level of the bottom of the subway structure, which latter is about 4 ft. below M.H.W.

Easements were obtained under the two pieces of private property referred to, namely, the Trinity Parish House and the old Astor Hotel, on condition that the former should be properly supported on new foundations, bridged over the tunnel, and that on the site of the latter (which was razed) suitable foundations for the heaviest type of building should be provided, also, of course, bridged over the tunnel where this passed through them. Under these conditions it was thought desirable to design two separate circular cast-iron lined tunnels or tubes. The two tubes together have a length of about 1200 ft. and will require about 4350 tons of cast iron for the lining and about 17,000 cu.yd. of concrete.

As these sections of iron-lined tunnel are comparatively short, the use of the usual type of pneumatic shield for driving them would have involved a somewhat high cost for plant, chargeable to only a small amount of work. Besides this, the driving of tunnels by the shield method on curves of as small radius as this is a somewhat difficult operation, though on the Hudson & Manhattan R.R. there is at the corner of Morton and Greenwich St. a curve of 150-ft. radius, which was successfully driven by the use of the shield. The diameter of these tunnels was, however, some 3½ ft. less than those at Vesey St.

The contractors, Messrs. F. L. Crawford, Inc., adopted therefore, for this work, a method developed by them and their engineer, J. C. Meem, M. Am. Soc. C. E., some years ago in the construction of some large circular brick trunk sewers in Brooklyn and which was quite fully described in a paper presented by Mr. Meem to the Brooklyn Engineers' Club in May, 1905.

This method as modified for the construction of these tunnels is shown quite clearly in the drawings and photographs, Figs. 73 and 74. A top heading is driven, the roof protection being afforded by the five sectional shields or jills, a detail of which is shown in Fig. 74d, and the front end in the photograph, Fig. 73-1. These are shoved ahead by hydraulic jacks, and a lining of 2-in. hardwood lagging put in behind them, under the tail; this is temporarily supported by crown bars and blocking, which

in turn are supported by segmental timbers consisting of the cap made of a 16x12-in. cut on top to chords of the curve and flat underneath to take the posts, and the two side pieces, as shown in the drawing, Fig. 74, a and b, and the photograph, Fig. 73-3.

From the heading, the sides are worked down to about the springing line (horizontal diameter) by placing the 5-ft. lengths of horizontal lagging much as it is placed in the pits for underpinning and as shown in the photograph, Fig. 73-3. To get out the excavation in the center below the heading, the top cap is carried temporarily on the 20-in. I-beams shown in Fig. 74(a), spanning the working space from the erected intermediate sill (the one just above the center of the circle) to the firm ground in the bottom of the heading.

This permits the advancement of the so called pilot girder, which is advanced along the center in the position line or deflected to fit the curvature. The girder flanges are 8x8x½-in. angles, and the latticing 4x4x½-in. angles. The girders are 3 ft. on centers held together and braced by 4x¾-in. bars. The roof load of the tunnel, which the girder supports, is estimated to be about 10 tons per lin. ft., but the girders are designed to carry a maximum load of 40 tons per lin.ft. for spans of 12 ft., thus providing for uncertainty and probable irregularity of loading and support.

The hardwood lagging is left in place when the cast-iron lining is erected. This latter weighs approximately 6600 lb. per lin.ft. of tunnel and it is cast in the usual segmental form. The individual segments are 6 ft. 2 in. long, 20 in. wide and weigh about 1500 lb. each. Every fifth ring is a taper ring for the curves, other taper rings (with considerably less taper) are provided for correcting the alignment when this becomes necessary.

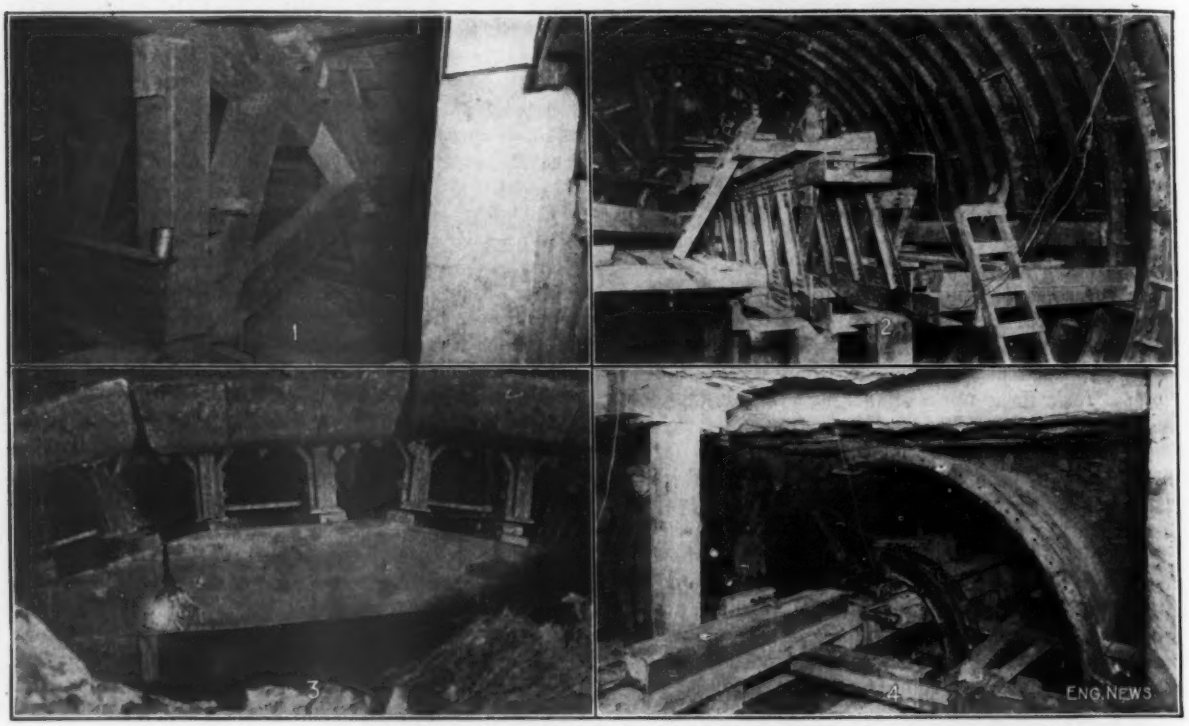


FIG. 73. VIEWS IN VESEY ST. TUNNEL

1. Temporary bracing and lagging.
2. Iron-lined tunnel and pilot girder.
3. Segmental roof shields—jills.
4. Tunnel and pilot girder, erector.

of the pilot tunnel of the old Anderson & Barr method. The girder in the present instance, however, only serves a purpose similar to that of the temporary I-beams above, that of supporting the overhead structure of timber blocking, over the working space, its rear end being supported on blocking from the erected iron lining, its front end on the unexcavated ground of the second lift just below the center. The photographs, Fig. 73 (2 and 4), show the method of using the erector around the pilot girder, and the latter part of the tunnel under the Trinity Parish House, which had previously been underpinned and the space above the tunnel bridged over.

The girder itself is made up in 12-ft. sections arranged so that the rear section can be detached and bolted on to the front, overlapping about 3 ft. Extra holes are provided so that the progress can be made either in a straight

In making the excavation the ground at the breasts, as well as the sides, is usually held at all points by lagging or poling bounds to prevent any subsidence or flow of material.

The Harlem River tunnels, the East River tunnels and the crossing of the Lexington Ave. subway under the New York Central R.R. tracks will be described in the next issue.

The Ordinance to Reduce Elevator Accidents in buildings (noted in "Engineering News," Oct. 29, 1914, p. 887) will be put into force in New York City on Jan. 1, 1915. The ordinance provides for an interlocking device on every elevator in use in the city, and makes it unlawful to operate any elevator otherwise. Elevators having the higher rises—16 stories or more—are to be equipped first, the time limit for these being Oct. 1, 1915. There are about 150 buildings in Manhattan which are 16 stories or higher.

The Design and Maintenance of Sewage-Treatment Works*

The use to which a stream is put and the available water for dilution should be factors in the design of every plant, and treatment should not be carried further than is made necessary by the conditions of the stream which is to receive the sewage after treatment. Where streams are used as sources of water-supply for near-by towns, a higher standard of effluent is required than where the purpose of the treatment works is only to prevent nuisance.

All disposal works should be recognized as machines which require intelligent supervision and which, if properly designed and maintained, can be made to produce just that quality of effluent which the diluting capacity of the local stream will render satisfactory. In this way greater general progress in the betterment of stream conditions will result.

It will frequently happen that, in small streams, the dry-weather flow can, with profit, be increased by the intelligent use of stored upstream water, and the discharge of a partly treated sewage thus made possible at all seasons.

Where the two-story type of tank is adopted care must be exercised that the tanks are not made too large, as under such circumstances they are liable to fail of their purpose by reason of the sewage in the settling chamber becoming septicized and creating nuisance.

PATENTED PROCESSES—Town authorities should not deal with the proprietors of any patented processes or devices for sewage treatment without the assistance of some competent advising engineer.

The treatment of sewage has always seemed to be a particularly fertile ground for the exploitation of patented methods, from the early days of the many processes of chemical precipitation to the present-day electrolytic treatment; many of these schemes, while apparently successful in the experimental plants, are entirely infeasible on a practical scale. There is danger in deducing results from small test apparatus without scientific study by a qualified expert; often the cost of such treatments, when undertaken practically, is prohibitive. The proprietor of a process who is looking for a contract will give a bond and make various propositions which appeal to the people of a town and in this manner lead them to favor the acceptance of such propositions. Many costly mistakes have been foisted on communities in this way.

PROCESSES OF TREATMENT

SEDIMENTATION AND SLUDGE DIGESTION—Usually the first process of treatment is the removal of the solid matters which have been maintained in suspension by the velocity of flow in the sewer. In the past, when the solids were allowed to settle in tanks in which the sewage flowed over and in contact with the putrescent deposits in the bottom, odors resulted. Also, when the deposit from such tanks, called sludge, was placed upon the ground or upon drying beds, the foul emanations added to the nuisance. But within recent years, two-story tanks have been devised and are in successful operation whereby the sewage is settled for a short period of time in the upper story and the sludge allowed to remain in the lower compartment of the tank sufficiently long for the decomposable matters to digest, and the settling sewage is kept from coming in direct contact with the digesting sludge.

Such tanks will discharge an effluent practically free of settleable matter in nearly as fresh a condition as when received. The gases evolved during digestion of the sludge away from contact with the sewage are principally methane or marsh gas and carbon dioxide, both of which are inodorous. Sludge withdrawn from such tanks after digestion is inoffensive, dries quickly and may be used for filling low land or for agricultural purposes with no danger of nuisance.

OXIDATION—If the conditions require more refined treatment than sedimentation, it becomes necessary to adopt processes for oxidation. This may be accomplished by means of intermittent sand filters, contact beds or sprinkling filters, the choice of which is largely dependent on the availability of different construction materials and the size of plant to be installed. Intermittent sand filters are only economical where large areas of sandy soil are available. The sprinkling filter, on the score of economy and on account of the maximum efficiency secured on a minimum area of land, is generally given preference; yet under certain conditions contact beds are justified.

The present-day tendency is to adopt processes which will maintain, as far as possible, aërobic conditions in the liquid at all stages through the plant; the maintenance of such aërobic conditions is the primary consideration in avoiding nuisance.

DISINFECTION—As the purpose of disinfection is the destruction of pathogenic bacteria, in order to provide a double safeguard against water-borne diseases, it can be generally said that disinfection of sewage is an unnecessary refinement, unless the effluent of the sewage-treatment works is discharged into a water course adjacent to and above the intake of a water-purification plant, and even in such a case the responsibility of protecting the public health should rest upon the purification of the water.

It is not practical to disinfect crude sewage containing particles of organic matter of appreciable size, as with the usual period of contact it is impossible for the disinfectant to penetrate the solids.

ODORS AND THEIR AVOIDANCE

The amount of odors depends largely on the freshness of the sewage and the method of treating and handling the sludge. The freshness of the sewage depends largely on time of travel and the design of the collecting system, on the adaptation of size to discharge, the provision for self-cleansing velocities and on the ventilation of the sewers so as to provide as much natural aëration to the liquid as possible. If the sewage is fresh or if, in other words, it contains dissolved oxygen, there will not be serious odors from the application or treatment of the liquid portion, provided the plant is maintained with no lodgment of sewage in pools or overloading of the surface of the filters.

There is a potential cause of odors in the sludge. But by the use of the more modern type of tanks, with thorough digestion of the decomposing solids and discharges on properly prepared sludge-drying beds, under favorable

*Condensation of a progress report of the committee on sewerage and sewage disposal, presented to the sanitary engineering section of the American Public Health Association, Jacksonville, December, 1914. The members of the committee are: Geo. S. Webster, Philadelphia, Chairman; Frank A. Barbour, Boston; Geo. A. Johnson, New York City; Langdon Pearse, Chicago; F. Herbert Snow, Harrisburg.

weather conditions, no odor of serious moment, noticeable more than a few hundred feet, should ever occur. Odors can be largely eliminated by good design, but their occurrence depends more particularly on proper supervision of the plant.

By the use of the two-story sedimentation tanks, which provide for the digestion of sludge, and by care in the management of the works, plants are operated in Europe and in this country where no odors are noticeable either from the sewage or from the sludge during drying.

In plants where other methods of treatment are adopted it is probable that odor will be produced. It has been estimated that at such a plant capable of treating the sewage of 50,000 people, with good management no odors should ever be apparent beyond 1000 to 1200 ft. from the works, even when sludge is being discharged upon the drying beds or in the spring when the filters are in bad condition, due to the past winter interfering with work being done on them.

With smaller plants this distance should be less, and with larger plants possibly more. By diffusion, of course, the odor becomes more faint as the above named distances are reached, and beyond these distances no odor should be noticeable. What might be termed odors, strong enough to be disturbingly disagreeable to a person whose nasal sensitiveness is not affected by his knowledge of the source of the odor, should, perhaps, never be found at a distance more than one-third of those mentioned. It should, however, be noted that an odor from a sewage plant which, if from a farm would never be noticed or would be accepted as simply natural and reasonable, will generally develop complaints of nuisance. Sentiment, regardless of facts, frequently blames on an inoffensive sewage-disposal plant bad odors from other sources. In short, sewage-treatment works should be as isolated as is economically possible.

For the avoidance of odors, the fundamental considerations are the delivery of the sewage as fresh as possible at the plant, the application of the liquid portion to filters before the sewage has become stale, and the proper treatment of the sludge so as to render it comparatively odorless and easily handled.

Making Sewage-Works Attractive by Planting Trees, Shrubs and Flowers

Disposal plants should be made attractive by planting and parking, and no money can be better spent than this. The trees to some degree prevent the spreading of the odors, and in the planting of trees and shrubs the direction of the prevailing wind should be taken into account.

Local authorities, when they first take up sewage-treatment for consideration, frequently look upon the plant as a dump for municipal waste, and it never occurs to them that it is good policy to spend money to make the works so attractive that people will voluntarily make it the objective point of their Sunday afternoon strolls.

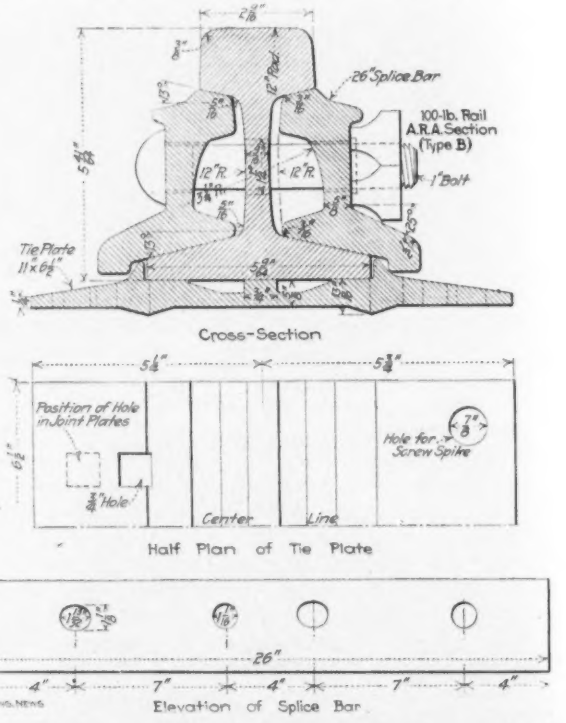
Such beautification and the proper maintenance of the appearance of the plant are the surest and best means of preventing complaints of odors or nuisance; this because of the psychological effect on those living near the plant, and also on the attendants, who unconsciously adopt a higher standard of cleanliness and care of the works.

Traffic through the Panama Canal in the first three months of operation, Aug. 15 to Nov. 15, amounted to 1,079,521 tons.

Rail Joints and Tie Spacing

In the work of rail renewals it has been general practice to shift the joint and shoulder ties to adjust them to the position and specified spacing at rail joints, since the joints of the new rails rarely coincide exactly with those of the old rails. This shifting of the ties and handling of ballast involves considerable work and time, and a large number of men; in fact, rail-renewal gangs of 158 men employed on one railway have 68 of these men assigned to the spacing of ties.

It will be understood that the shifting of the ties results in a disturbance of the ballast and of the firm roadbed which has been secured by months of tamping and maintenance work, and several months of such work will be required again to restore the roadbed to its former condition. This means that much of the expense due to



Rail Joint with Heavy Splice Bars; Pittsburgh & Lake Erie R.R.

J. A. Atwood, Chief Engineer.

(The rails are laid without regard to the position of the ties at the joints.)

the shifting of ties is not charged up to that work but is charged to ordinary maintenance.

There is a growing doubt as to whether this work is necessary and whether it is worth the expense and trouble involved. This is especially the case for main track laid with heavy rails and splices. Some amount of tie shifting will be necessary where the splices are of a type that projects below the rail base, or where the old plan is followed of slot-spiking the splice bars to prevent creeping of the rails. In modern practice, however, the tendency is to use rail anchors or anti-creepers for this latter purpose.

The practice of laying new rails without reference to the position or spacing of ties at the joints has been adopted by some important railways, and with entirely satisfactory results.

The Pittsburgh & Lake Erie R.R. has followed this practice for two or three years. The rail joints are spliced with bars of high-carbon oil-tempered steel, having a large proportion of metal in the top chord, as shown in the accompanying cut. These are hot-punched for the bolt holes. The use of slotted splice-bars has been discontinued for several years, as it was believed poor practice to rely on the joint ties to prevent creeping. It is considered that the preferable method is to use sufficient anti-creepers to prevent such movement. The maintenance engineers and the track men are convinced that the practice of keeping ties with uniform spacing, and regardless of the position of the rail joints results in considerable direct and indirect saving, while the track rides very easily.

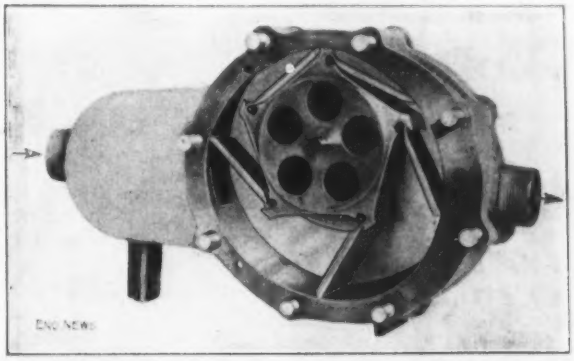
The Illinois Central R.R. has adopted (in 1914) a new design of heavy high-carbon angle splice-bar for 85- and 90-lb. rail. The bar is not slotted or punched for spikes, as it is intended to use anti-creepers to hold the rail where there is any tendency to creep. No attention is paid to the spacing of the ties when the new rails are laid, and respacing will be done only at such times as the track is surfaced "out of face." It is considered that a great economy in rail-renewal work is effected in this way. The same conditions apply on the Lehigh Valley R.R., where the opinion is held that the respacing of ties involves an expenditure of time and money that gives no good results, while the time might be spent to much better advantage in maintenance work upon the track.

A Direct-Reading Volumetric and Velocity Meter for Measuring Fluid Flow

In a meter for fluid measurements which is now being introduced, the meter chamber is divided into a series of compartments by means of vanes or blades on a revolving drum, and the volume and velocity of flow are determined by recording the number of compartments passing the discharge port. The revolutions are recorded on a register which gives direct readings of the volume and velocity.

The fluid entering from the pipe connection passes through a screen chamber (packed with sponge or other material suitable for arresting solid matter), and then enters the meter chamber through a port in the end wall. This chamber is elliptical in form and within it revolves a drum to which are attached hinged vanes, which are held out in contact with the side of the chamber by springs as well as by centrifugal force. The pressure of the fluid against the vane beyond the inlet port forces the drum to revolve, and when the next vane passes the port a definite volume of the fluid is isolated between the two vanes. As the first vane reaches the enlarged section of the chamber at the outlet end, the fluid escapes through the discharge pipe. A counter on the spindle of the drum is graduated to give a direct reading in cubic feet (or other volumetric measurement) The accuracy is claimed to be within 0.25%.

The chamber and springs are of phosphor bronze, and the vanes of hard brass. There is very little wear of the contact surfaces as the difference in pressure on opposite sides of the vanes is very slight. In the meter with 1-in. pipe connection, the chamber has diameters of 7½ and 7 in. on the major and minor axes, and is 2½ in. wide, while the size of the meter over all is 15½x9x9 in. At present the meters are made in sizes of ½-in. to 2-in. but larger sizes have been designed, including an oil-pipe-line meter to be put on a 48-in. main. They have been applied mainly for metering of compressed air, but are suitable for any fluid or liquid, and a modified design has been prepared for use with high-pressure steam. One field of application is on the pipes of oil-tank steamers. The amount delivered on board is measured and recorded, and the consumer can see that this same amount is passed through the meter in being pumped from the vessel to the tanks.



THE KREUZBERG DIRECT-READING VOLUMETRIC AND VELOCITY METER WITH END PLATE REMOVED

Several railways and factories are said to be using the meter on compressed-air piping to determine the proportions of the total supply that are delivered to different departments, so that proper charges can be made against these departments. Compressed-air tool companies also are using them to test the consumption of air by tools of different kinds or sizes or to test the consumption of a tool when new and after a period of service. In this latter case, if the consumption has increased excessively, the tool may be subject to inspection to determine where the leakage occurs and how this can be reduced so that the tool will retain its original efficiency for a longer period. Further, tools may be tested periodically, and sent to the toolroom for repair when they show an excessive consumption of air.

The device is known as the Kreuzberg volumetric and velocity meter, and is being introduced by J. S. McChesney & Co., 139 No. Clark St., Chicago.

A Toll Road of Concrete for use by automobiles is projected by the Texas Concrete Motor Highway Co. of Austin, Tex. The company proposes to build a network of concrete toll roads in Texas and estimates the average cost of constructon at $20,000 per mile. It plans for the sale of toll privileges to automobile owners at the rate of $50 per year, and estimates that an average toll rate of 1c. per mile would be sufficient to make the enterprise a paying one. The reduced cost of fuel on such a smooth roadway compared with the power required to drive a machine over the ordinary dirt roads, with the reduced wear on tires, would make the patronage of the road an economy for automobile owners. Inasmuch as the only traffic over the road would be rubber-tired vehicles, with no wear from steel tires or horses' hoofs, it is claimed that the cost of maintenance of the road once well constructed would be practically nothing. A law passed by the Texas legislature in 1913 permits the organization of toll-road companies in Texas and gives them the right of eminent domain to secure their right-of-way. The general attorney for the company promoting this enterprise is Worth S. Ray, 601 Littlefield Bldg., Austin, Tex.

A New Flat-Slab Reinforced-Concrete Floor with Striking Features

The Harvard Avenue shops of the Cleveland Railway Co., Cleveland, Ohio, are being built with a rather remarkable reinforced-concrete floor construction, invented by David Morrow, of the firm of Morrow & Cross, civil and architectural engineers, Cleveland. The prominent feature of the Morrow floor is the arrangement of the columns in substantially equilateral-triangle grouping. This means, of course, that successive rows of columns are staggered, instead of being square and opposite, as in all other

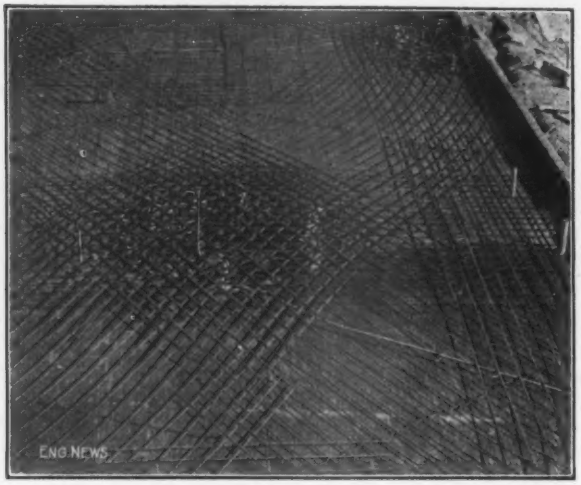


FIG. 1. VIEW OF REINFORCEMENT OF MORROW FLOOR, READY FOR CONCRETING

floor systems. Naturally corresponding to this column arrangement is the reinforcement of the floor. The bands of rods run in three directions 60° apart, crossing over the columns. The view in Fig. 1 and the plan in Fig. 2 show this very clearly.

A second feature of the Morrow floor is the omission of any special secondary reinforcing means at the column head. Simple rod supports or form-spacers carry the bands of rods and hold them up at the right level until

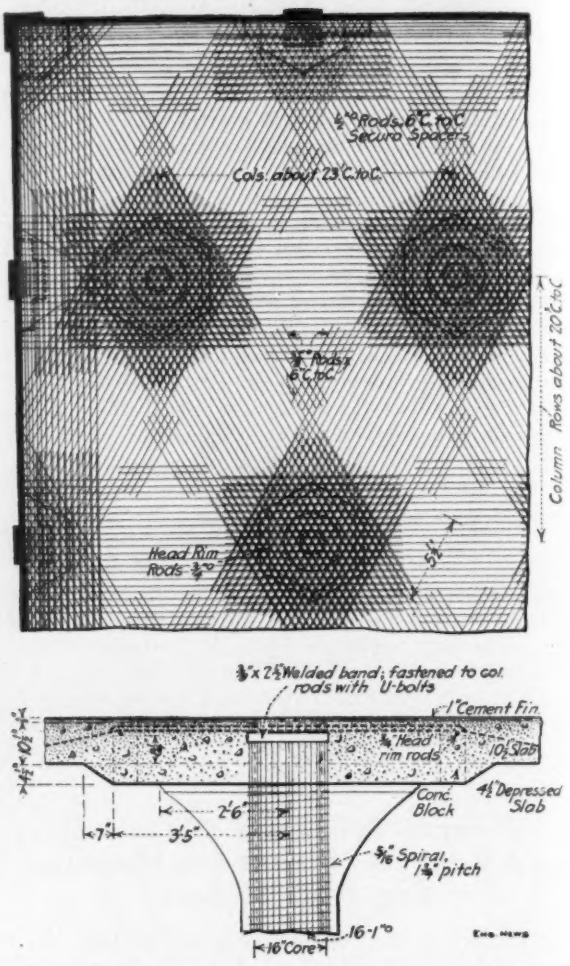


FIG. 2. FLOOR USED IN STORE BUILDING AT HARVARD AVE. SHOPS OF CLEVELAND RY. CO.
(New floor invented by David Morrow)

the concrete incases them. The nature of the support will be seen from the sketch. Polygon rods are set on concrete blocks of such height as to bring the reinforcement into the top of the slab.

FIG. 3. VIEW SHOWING STAGGERED COLUMN ARRANGEMENT OF MORROW FLOOR

The inventor's leading idea in the arrangement of reinforcement appears to be that there is greater symmetry of the reinforcing metal, that is, a more equal distribution of the reinforcement in all directions from the column than in other systems. From this he concludes that the reinforcing metal can be placed in the slab more nearly in proportion to the stresses than other systems permit, which fact should mean economy. The Morrow patent is 1,064,850, dated June 17, 1913.

The buildings of the Harvard Avenue shops cover an area of about five acres and cost about $1,000,000. The Morrow slab is being used in the store building, 184 ft. by 120½ ft., in the 50x80-ft. floor over the basement of

the armature room, and over the 57x30½-ft. basement of the oil-storage building. Further, the roof over the 150,000-gal. fire-protection reservoir (55x32 ft. by 13 ft. deep) is of the Morrow system, and a similar reservoir (48x28 ft. by 11 ft. 3 in. high) is being built at Lake View Road and Superior Ave.

In constructing this reinforced work the rods were wired at all their intersections. This apparently tied them sufficiently to prevent chance displacement, as the runways for the concrete buggies were laid directly on the reinforcement, and often the buggies were turned out from the runways and run short distances to points of unloading directly on top of the reinforcing steel without disturbing the position of the bars.

Fundamental Planks in a Public-Utility Program*

By Delos F. Wilcox†

I have sometimes spoken of the relation between a city and its privately owned public utilities as an irrepressible conflict. The expressions "traction war," "gas fight," "telephone controversy," "electric light dispute," etc., are familiar to everyone. In the picturesque language of the newspaper and the street, public-service corporations have long been described as public enemies, and the attitude of belligerency toward them has become chronic in many, if not most, American cities.

While this antagonism often assumes exaggerated, unintelligent and even fantastic forms, and while there is a substantial community of interest along many lines between the public and the utility corporations, we must not blink the fact that there is a permanent and fundamental conflict of motives between them. No amount of regulation and no possible development of good will and the spirit of coöperation can change the fact that private corporations operating municipal utilities do so for profit and for as much profit as they can get, while the consumers and the public strive to get as much service as they can at the least possible cost.

The discussion of plans of campaign against high rates, poor service, political interference, financial tyranny and all the rest of the evils which we have set out to smite can only lead to confusion of counsels unless we clearly grasp certain underlying issues involved in the relations between the cities and the public utilities. Without having definite thoughts on these issues, we can not think straight on anything else, and without knowing what any particular speaker's thoughts upon them are, the rest of us can have no measure by which to gage the importance or fathom the meaning of what he says.

The underlying issues are:

(1) What shall be the recognized character of public-utility investments?

(2) What shall be the attitude of the city toward public utilities as money-earning enterprises?

(3) What attitude shall the cities take toward ultimate municipal ownership?

I shall answer categorically, according to my lights, the questions I have propounded under these three heads:

*Condensed from a paper read before the American Mayors' Conference on Public Policies as to Municipal Utilities, held at Philadelphia, Penn., Nov. 13 and 14, 1914.

†Consulting franchise and public-utility expert, 93 Nassau St., New York City.

(1) Character of the Investment

Public-utility investments should be placed upon a nonspeculative basis, and their security should approximate that of municipal bonds.

In the establishment of the nonspeculative character of these investments, *cities should not undertake to make good past losses.*

So far as future investments in the standard utilities are concerned, *the cities should assume the risks of loss due to unforeseen causes,* and should substantially guarantee the integrity of all investments made at the request or with the approval of public authority.

(2) Public Utilities as Money-Earning Enterprises

In my judgment, public utilities should not be regarded as a legitimate source of profit to be used for the relief of general taxation.

Compensation for franchise grants, and special taxes or license fees imposed upon public-service corporations should not be encouraged, unless the proceeds of such compensation or taxes are to be used in paying for the property.

Every individual public utility should be made to render a clear account of itself and, as a general rule, should be self-supporting.

Public-utility services should be rendered as nearly at cost as practicable, except that the rates should include a sufficient contribution to retire the investment within a definite period of time.

Public utilities should receive credit for all the service rendered by them to the city and its various departments, but only under unusual conditions should the city assume to subsidize a public-utility service out of the proceeds of taxation or otherwise.

(3) Ultimate Municipal Ownership

In my opinion, cities should *not* assume that public utilities are to remain permanently as private investments under private operation.

On the contrary, they should assume that all the well established utilities will sooner or later be publicly owned, private capital being entirely excluded from the public streets except as it is loaned to the city.

In their franchise grants, and in all contracts affecting rates or granting privileges, the cities should establish the option to take over the utilities either at pleasure or at reasonable fixed intervals.

Wherever possible, the cities should go still further and without more delay definitely set in motion the machinery necessary to compel the gradual withdrawal of private capital from the public streets and the gradual acquisition of the utility plants by the cities as public property.

Subway Contracts in New York—The total contract price of the 64 subway sections on city owned lines already awarded is $146,253,346, of which $76,172,289 is on Interborough lines and $70,081,056 on the New York Municipal lines. In addition to these, the Interborough Rapid Transit Co. has under way third-tracking of the Manhattan and Bronx elevated lines, the first of which is estimated at from $8,000,000 to $10,000,000, and the New York Municipal Railway has under way elevated third-tracking and extension contracts involving an outlay of upward of $6,000,000, so that the grand total of work now going on in different parts of the city on the dual subway system involves an expenditure of about $152,000,000 contracted for on Dec. 1, 1914.

Field and Office

Methods of Filling and Dredging for a Jersey City Freight Terminal*

Extensive dredging and filling operations on the Jersey City water-front at Communipaw, which have been in progress for the past 14 years, are now approaching completion. The work is in a district known as the Tidewater Flats, and amounts to about 6000 lin.ft. of water front averaging 4000 ft. in width. On the ground thus made a freight terminal of the Central R.R. of New Jersey is being constructed. The filled-in strip is immediately back of the government bulkhead line, at which is being constructed a timber-crib bulkhead on hard-bottom foundation. It is built as the dredging and filling proceeds. The extent of the work is shown by Fig. 1.

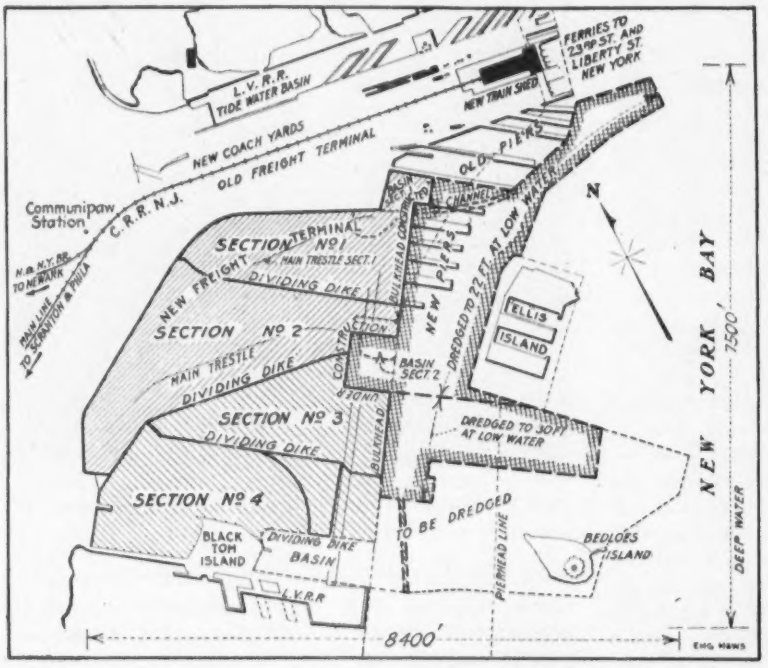


FIG. 1. PROGRESS MAP OF FILLED AND DREDGED AREAS, JERSEY CITY FREIGHT TERMINAL

Back in 1900, when the work was started, under permission granted by the War Department in 1898, the first operation was to float in a large number of old canal boats, fill them with stone and sink them from 400 to 500 ft. back of the bulkhead line. Just back of the canal boats an earth dike was made by unloading (by hand) cellar dirt from scows. The dike formed by the earth-backed canal boats prevented the new fill from being washed away by the tides. At various points back of this dike transverse dikes were built. Then the general filling-in operations began. These were carried on in four sections, three of which are about finished and the fourth under way at the present time.

On section 1 and a part of 2 the general manner of conducting the work was to build trestling over the section, beginning at a basin dredged in the northeast corner of the section and connected to the bay by a channel. Mud and dirt brought in on scows were unloaded onto cars on the trestle by clam-shell and orange-peel buckets on floating dredges, and the cars taken out on the trestling and dumped. When the fill was brought up above mean-tide level, it was dressed with dirt.

Work on a section was carried on continuously; the material dredged outside the bulkhead line of each section was deposited inside the line. Section 1 was filled principally by the dump-car method described; but sections 2

*Information furnished by C. M. Titsworth, Assistant Engineer in Charge of Construction, Jersey City Terminal, Central R.R. of New Jersey.

FIG. 2. PANORAMIC VIEW OF FILLED

(At left is freight terminal of Lehigh Valley R.R. at Black Tom (see Fig. 1):

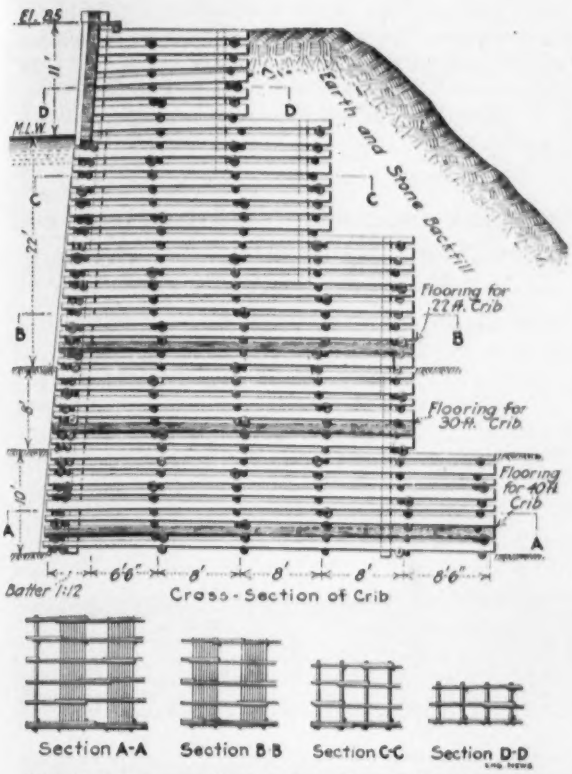


FIG. 3. TYPICAL SECTIONS OF LARGE TIMBER CRIB

and 3 were filled mainly by the action of large suction dredges. From the 800-hp. centrifugal pump of a dredge the discharge line was carried on pontoons to a pipe trestle extending out from the fill, thence over the made ground and discharged where desired, which was sometimes 6500 ft. distant from the dredge. As high as 190,000 cu.yd. of mud, sand and soft clay were put ashore in one month by one of these suction dredges.

THE DREDGING PLANT

The powerful dredging plant consisted of as many as six units, working simultaneously on different classes of work. A suction dredge furnished hydraulic fill; a ladder dredge removed hardpan; two dipper dredges dug trench for the crib and removed hardpan, while two clam-shell bucket dredges unloaded material from scow to dump car, and placed fill immediately back of the bulkhead.

HYDRAULIC FILLING—The suction dredges used are described as follows: Length, 160 ft.; width, 40 ft.; draft, 11 ft.; three boilers of 300 hp. each. The pump itself is 13 ft. high by 2 ft. 4 in. wide, and has a 5-bladed impeller which revolves at 350 to 400 r.p.m. The normal discharge pressure of the pump is 40 to 60 lb. per sq.in., and the diameter of the discharge pipe is 24 in. Solids amounted to about 5% of the total discharge, the water returning through a sluiceway.

The cutter consisted of a series of 6 heavy plates, each 6x1½ ft., varying in thickness from a cutting edge to 5 in., attached to a frame which revolves at 7 to 10 r.p.m. It is placed directly above the suction pipe and cuts the bottom so that the material can be taken up by the suction. An important feature of a fill thus made is that the harder and heavier materials are deposited at or near the point of discharge, so that by fanning the pipe line out in several directions a good, hard fill is left at the top, requiring no further dressing.

This plant was used on section 3. On section 2 the same method was employed, but the plant was not quite so large—an 18-in. discharge line was used.

DREDGING HARDPAN—In addition to the dredging of the materials used for the fill, a considerable amount of hardpan dredging and the removal of some rock were required in order to obtain the required depth of water. This hard dredging was accomplished by two kinds of plant; one, of two scoop or dipper dredges of 8 cu.yd. capacity each; the other the endless-chain bucket-conveyor dredge, with 29 buckets of ⅞ cu.yd. capacity each, as illustrated in *A* (Fig. 4).

This latter dredge is a familiar type in Europe, but is not used largely in the United States. The one used on this particular job has a 175-hp. boiler supplying two 150-hp. engines geared to the shaft which operates the buckets.

NEW CRIB BULKHEAD

When a section was filled from the main dike west, the permanent timber-crib bulkhead was built on the government line. The first step was to dig a trench down to hard bottom for the crib foundation. Accurate soundings were then taken to enable the crib builders to frame the crib sections, as the hard bottom ran as deep as 40 to 50 ft. below mean low water in some cases, while in others hardpan had to be removed. At other places where considerable inflow was expected in the trench, a rock fill was made as soon as the dredging was completed, and on it the cribwork was erected.

A cross-section of the crib is shown in Fig. 3. It is

SITE OF NEW FREIGHT TERMINAL

at upper right is a dipper dredge digging trench for timber crib bulkhead.)

formed by framing round logs together on the surface of the water, notching to fit, and spiking them together. The crib was divided into square bays of about 9 ft. dimension, in which stone was dumped to give stability. After sinking and completing, the crib extended about 10 ft. above low water. The fill was even with the top.

Spoil Handled and New Pier Construction

The land reclaimed to date comprises an area of about 270 acres filled to about 10 ft. above low water. The water in front of the improvement has a depth of 22 ft. at low water at its northerly half and will have, when completed, a depth of 30 ft. at low water at its southerly half. Material amounting to 10,000,000 cu.yd. of mud or silt, sand and clay has been put ashore by various operations; and about 1,000,000 cu.yd. of hardpan with some rock have been dredged and towed to sea; 2250 lin.ft. of crib bulkhead have been built, and 3460 lin.ft. are at present under contract.

In front of the area filled, six new piers have been built since 1905 with an aggregate length of 4475 ft., giving a length of stringpiece available for shipping of about 9500 ft. Several more will be built in the near future.

The general construction of the open piers is creosoted piles on rock foundation, with full creosoted deck carrying four tracks. The covered piers are of creosoted piles to rock, concrete deck, galvanized-iron siding on steel frame, with tar-and-gravel roof.

Personnel

The Taylor Dredging Co., of New York, has the general contract for the dredging and filling. The hydraulic dredge shown belongs to the Metropolitan Dredging Co., of New York. The work has been done for the Central R.R. Co. under the direction of Joseph O. Osgood, Chief Engineer, and A. E. Owen, Principal Assistant Engineer; C. M. Titsworth is Assistant Engineer in Charge of Construction.

Special Subway Timbering on Section 1, Lexington Ave. Route, New York

A double method of support is employed for the timbering on the Broadway line, Morris to Dey St., of the Lexington Ave. subway, New York City. On this section, support has to be provided for both a double-track street railway and an elevated line. The features of this special timbering are the combined arching and bracing secured and the use of a continuous girder throughout the length of the excavated section, supported on posts or hollow piles.

Placing the timbers as shown in the diagram practically secures the support of the whole structure from the two side piles at *A*, to which the load is transmitted. The continuous longitudinal girders *B* also afford independent support which is not likely to be wholly destroyed even by the failure of several of the columns below. This design, it will be noted, provides for the secure support of the dense overhead traffic without the use of an excessive amount of timber and makes ample allowance for contingencies and the possible failure or permissible removal of one or more of the supporting posts or columns.

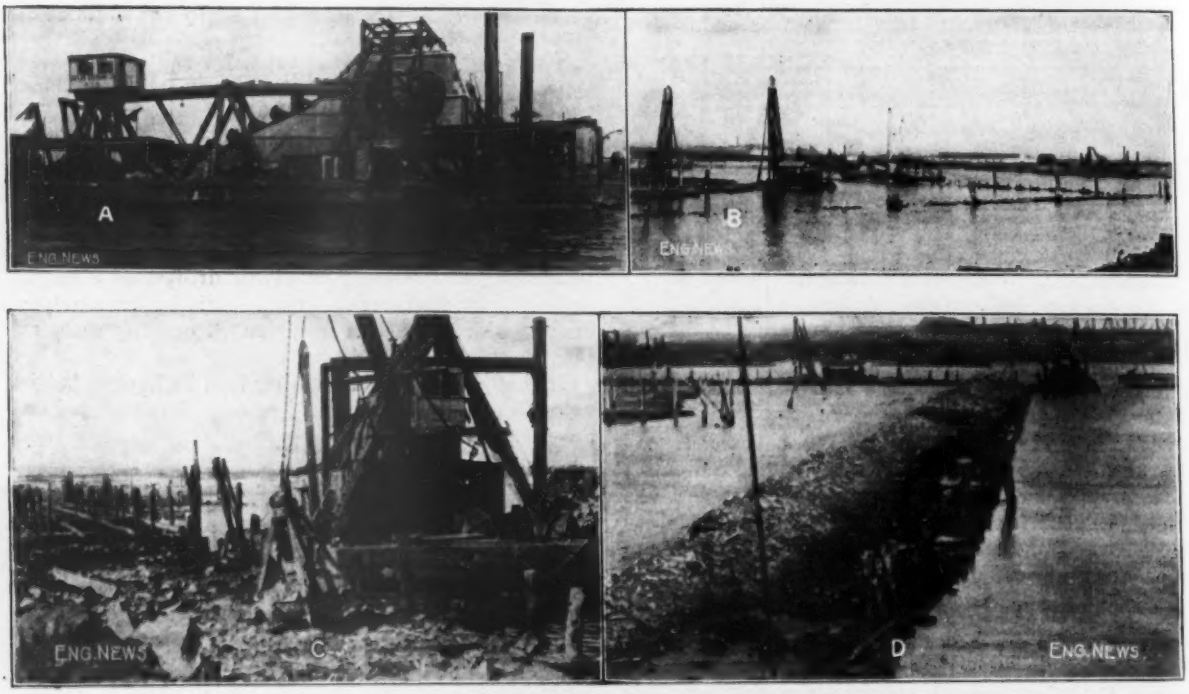
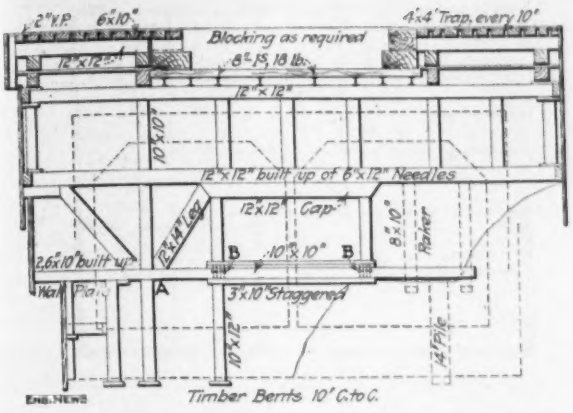


Fig. 4. Views of Contractor's Plant and of Work at Various Stages

A—Ladder dredge removing hardpan. B—General view of bulkhead work at low water. The derrick is completing the filling of the crib. C—In background is crib, framed up to low water, ready for sinking. In foreground is backfilling machine which, after crib is filled with stone, places cellar dirt and rock against back of crib to give greater stability and to prevent fill water from washing through. D—Stretch of filled crib at low water; backfilling machine in distance. Ragged appearance of crib fill is due to mud pockets and highspots which will be evened between low water and high water.



SPECIAL SUBWAY TIMBERING ON SECTION 1, LEXINGTON AVE. ROUTE, NEW YORK

Reference was made to this method of timbering by Fred Lavis in his seventh article on "New York Rapid Transit Railway Extensions," in ENGINEERING NEWS, Nov. 26, p. 1071.

Tamping Track with Air Power*

Pneumatic tamping of ballast under railway ties has been tried successfully on the River Division (West Shore) of the New York Central Lines. The tamper used in this work is very similar to a valveless hand-hammer or pneumatic drill, but fitted with a special tamping bar.

TAMPING OUTFIT—A complete outfit or unit consists of two tie tampers and a portable gasoline-driven air-compressor, with 600 ft. of hose. The car which carries the compressor outfit is self-propelled and geared for a speed of 12 to 15 mi. per hr. It has space for a gang of 12 men, weighs 1700 lb., and can be removed from the track by four men in 45 sec. This quick handling is effected by the aid of a special derailing wheel at each end, these wheels being at right angles to the track.

Each tamping machine weighs 37½ lb. and can be manipulated by one man. It is provided with two spade handles placed at right angles to each other for easy handling. The air pressure is 80 lb. at the tamper and the consumption is about 20 cu.ft. of free air per minute.

In tamping a tie a pair of tampers is always used, one tool on each side of the tie, operating at an angle of about 45° toward each other. A tie can be tamped in two minutes. The tamping bar is curved to permit easy tamping under frogs and switches, and in other contracted places.

NEW YORK CENTRAL TEST—The tamper was tested on a 1600-ft. section of track where new rail had been installed. Of this, 800 ft. were hand-tamped and 800 ft. tamped by the pneumatic tamper. This was done in 1913; after six months of heavy traffic the track was inspected, with the following results:

Greatest Settlement		Least Settlement		Average Settlement	
Hand	Machine	Hand	Machine	Hand	Machine
0.116 in.	0.063 in.	0.018 in.	0.004 in.	0.067 in.	0.033 in.

COST OF OPERATION—The cost per hour of operating a unit (compressor and two tampers), with gasoline at 20c. per gal. and gas-engine oil at 40c. per gal., was found to be: gasoline, 32.6c.; oil, 1c.; labor, 34c.; total, 67.6c. The average number of ties tamped per hour was 26, at a cost of 2.6c. each. The average number of ties tamped per day of 5½ hr. was 140. In this test the track was lifted from 2 to 4 in. G. W. Vaughan, Engineer of Maintenance-of-Way, under whose direction this test was carried out, believes that an average of 300 ties can be reached in a 10-hr. day.

The road now has 12 of these outfits in service. The pneumatic tampers and the compressors are manufactured by the Ingersoll-Rand Co., 11 Broadway, New York City.

*An electric tamping device invented by Mr. Collet, and used on the Paris, Lyons & Mediterranean Ry. (France), was described in "Engineering News," June 23, 1904. Each tamping bar was operated by a horizontal motor mounted on a pair of small wheels to ride on the rails, the two opposite motors being connected by a cross bar. An extension shaft from the motor drove the inclined tamping bar by gearing, the bar sliding in a guide fitted with cross handles held by the operator. Current was generated by a plant on a light motor car, and this car (like the gasoline car described above) had wheels at right angles to the rails to facilitate running it on and off the track as required. A light portable transmission line was used. The same equipment was used for driving screw spikes.

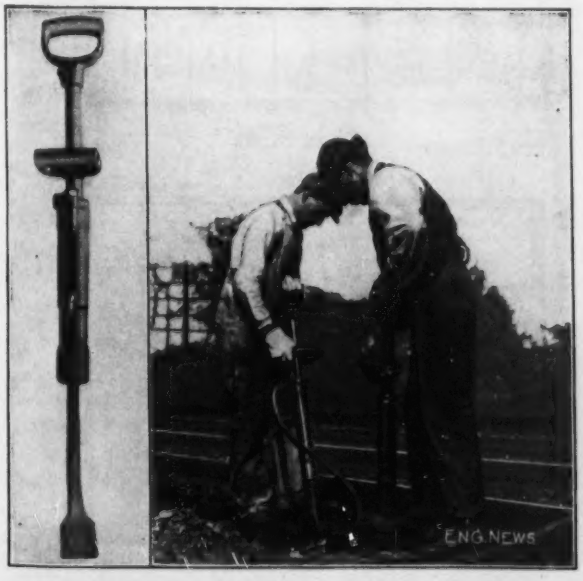


FIG. 1. A TAMPING UNIT IN ACTION

FIG. 2. A TRACK-SURFACING GANG; COMPRESSOR CAR AT LEFT

(Small transverse wheels are provided under the car so that it may be easily slid from the track on a temporary track of 2x4 scantlings.)

A Water-Supply Main at Keyser, W. Va., was packed full for 50 ft. recently by roots from a single poplar tree. The pipe was a gravity supply main of vitrified tile with cemented joints, and had been laid for over twenty years. The roots nearly stopped the flow of water in the pipe.

City of Jacksonville Engineering Building

By W. P. Darwin*

Structures for housing the engineering staff of a city are few and far between. Such a building was erected in 1911 by the City of Jacksonville, Fla., and besides being most convenient and satisfactory from the strictly utilitarian viewpoint, it is an ornament to the city and lends an air of thrift and business enterprise to Jacksonville which would be creditable to a city of larger size.

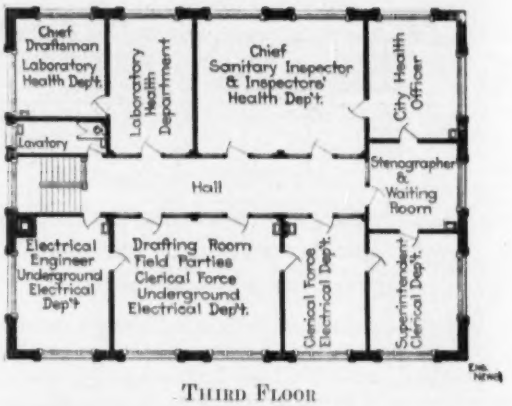
The building is 55½x73 ft. 10 in. in plan and has three stories and a well lighted basement. It was built

Fig. 1. The City of Jacksonville Engineering Building

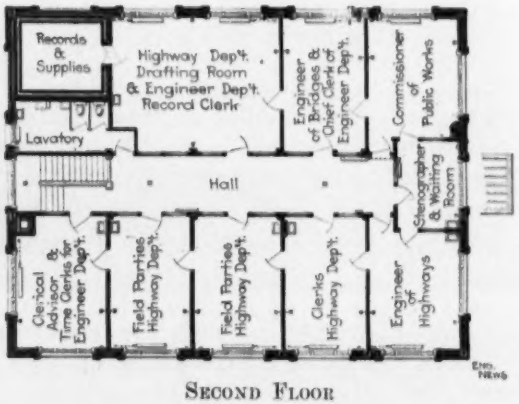
of reinforced concrete, faced with brick. It is electrically lighted, steam heated and each floor is provided with fireproof storage vaults. Besides having the service of the two telephone companies, an inside telephone system connects all the department heads.

A general view of the building is shown by Fig. 1. The four floor plans, showing the layout of the building and its assignment to different purposes, are presented at the right. It will be noted that the first and third floors are shared with other departments.

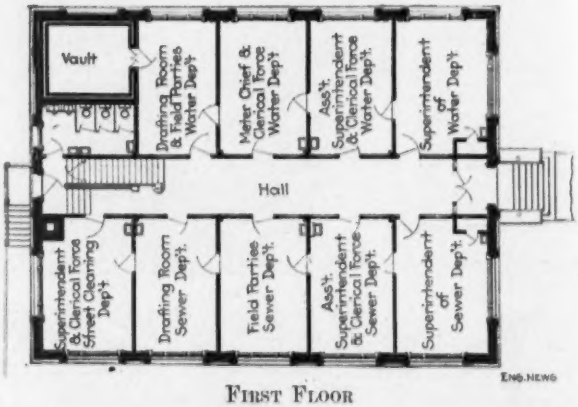
The total cost of the building was about $42,000. It was erected under the direction of the Board of Bond Trustees. William Bostwick, Jr., was Chairman of the Board and it was under his efforts that the project was executed.



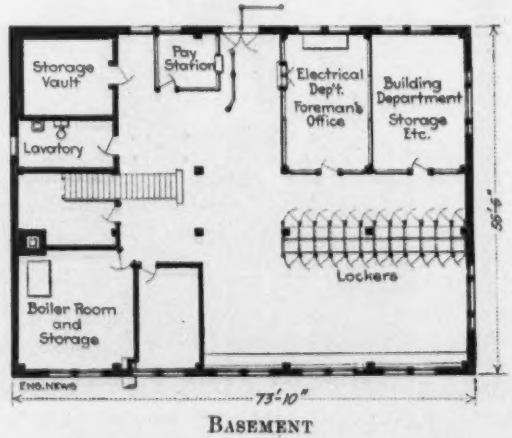
Third Floor


Records & Supplies
Highway Dep't. Drafting Room & Engineer Dep't. Record Clerk
Engineer of Bridges & Chief Clerk of Engineer Dep't.
Commissioner of Public Works
Lavatory
Hall
Stenographer & Waiting Room
Clerical Advisor Time Clerks for Engineer Dep't.
Field Parties Highway Dep't.
Field Parties Highway Dep't.
Clerks Highway Dep't.
Engineer of Highways
ENG. NEWS

Second Floor


Vault
Drafting Room & Field Parties Water Dep't.
Meter Chief & Clerical Force Water Dep't.
Ass't. Superintendent & Clerical Force Water Dep't.
Superintendent of Water Dep't.
Hall
Superintendent & Clerical Force Street Cleaning Dep't.
Drafting Room Sewer Dep't.
Field Parties Sewer Dep't.
Ass't. Superintendent & Clerical Force Sewer Dep't.
Superintendent of Sewer Dep't.
ENG.NEWS

First Floor



Basement

Concrete Anchor Piles for Steel Sheeting

A new coal pier at Sandusky, Ohio, built by the Pennsylvania Lines for loading coal into vessels, has its concrete wall supported partly upon timber cribs and partly upon concrete piles in a single line of steel sheeting. This sheeting is composed of interlocking piles, and as the depth of loose material over the rock is very slight, the special reinforced-concrete anchor piles are used to hold the sheeting in place as well as to carry the vertical load.

The anchor pile, Fig. 1, is octagonal in plan, 18 in. diameter, reinforced by eight 1-in. vertical rods which are hooped at intervals of 12 in., the hoops being looped

*Engineer of Bridges, Jacksonville, Fla.

around each rod, as shown. At two opposite corners are inserted the two halves of a split steel pile, the stems being held together by ¾-in. bent tie-rods. The steel sheeting engages with the projecting portions of the steel pile. In the center of the pile is a 6-in. pipe, and when the pile was in place a drill was dropped through it and a hole drilled into the rock. An old car axle was then

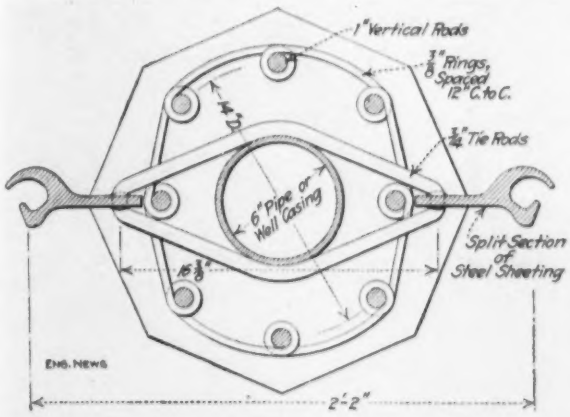


FIG. 1. SECTION OF REINFORCED-CONCRETE ANCHOR PILE USED IN A LINE OF STEEL SHEETING

dropped into the hole and grouted into the rock and the pile, thus anchoring the pile securely.

The construction of the dock is shown clearly in Fig. 2. The anchor piles are spaced 8 ft. 9 in. c. to c., and at the center of each panel of steel sheeting is a horizontal anchor rod attached to the top of the sheeting and anchoring it to a concrete beam on the opposite side of the pier. Each of these anchors consists of a pair of 2-in. rods secured by washer plates to old rails at either end, and

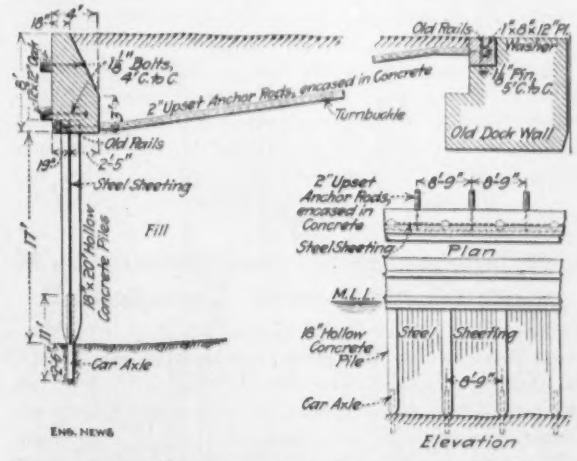


FIG. 2. PIER WALL CONSTRUCTION WITH STEEL SHEETING HELD IN PLACE BY CONCRETE ANCHOR PILES

the rods are incased in concrete for their entire length. This construction was designed and built by the Great Lakes Dredge & Dock Co., of Chicago, and has been used in the Black Rock harbor work at Buffalo, as well as at the Sandusky pier. For drawings we are indebted to the engineers of the Pennsylvania Lines.

A somewhat similar construction of pile, but intended to be used to form interlocking sheeting, was part of an alternative design for the new municipal pier at Chicago, but is not being used in the work now being constructed. As shown in ENGINEERING NEWS of Sept. 18, 1913, the pile was rectangular, 24x18 in., with half of a steel sheetpile embedded in each end, so as to make the piles interlocking. The socket part of the steel was flush with the face of the pile, so that the piles would be in close contact when driven.

A Small Incubator for Testing Water-Chlorination Results at Hudson Falls, N. Y.

BY M. F. TIERNAN*

In connection with liquid-chlorine apparatus recently set up in three hours' time at Hudson Falls, N. Y., there was also supplied an incubator to enable the operator of the chlorine apparatus to make daily tests for the presence of B. coli in the raw and treated water.

A special incubator was devised for the purpose. It is 10x10x14 in. in size and is heated by two 16-cp. lamps. Bimetallic thermostats hold the temperature to within ½° C. The equipment also included two dozen 1-c.c. glass pipettes, a small sterilization case, one dozen ground stoppered bottles for samples and 100 lactose bile tubes. The glassware is sterilized by putting it in an ordinary basting pan in the oven.

The attendant was instructed to take samples of raw water and treated water in the sterilized bottles and then inoculate the bile tubes with 1 c.c. of the samples. They would then be incubated for 72 hr., which is the standard method for such work, and if B. coli were present there would be a formation of gas in the bile tubes.

Error or carelessness of any kind on the part of the attendant will be counted against him in the bacteriological results. If he should not have the glassware thoroughly sterilized or should be careless in taking samples or in making the inoculations, he will get results which will show. On the other hand, if the lactose tubes show no growth he can then be sure there are no B. coli present and that he has added the proper amount of chlorine.

We find that the water requires different amounts of chlorine at different times of the year for proper disinfection. Temperature, rains, and other meteorological conditions enter into the problem of water disinfection, and the whole thing centers in the question whether or not enough chlorine is added to destroy the B. coli.

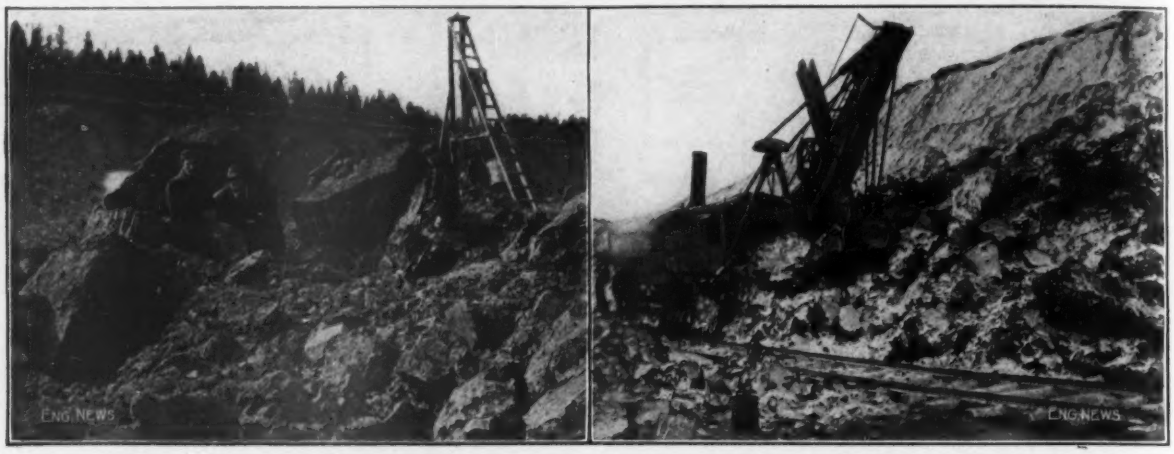
The writer was gratified to find that the water-works officials entered into this scheme with enthusiasm, and is quite sure that they will give the chlorine apparatus careful attention when they can see for themselves the effect the chlorine treatment has upon the water.

NOTES

To Smooth Out Old Plans—When it is desired to flatten out old mounted plans, old paper drawings or old cloth or paper prints, the following method has been found to work successfully in every instance where harsh handling or reverse rolling would ruin the appearance of a drawing: Make a thick, boiled starch of flour by boiling flour and water down

*President, Wallace & Tiernan Co., Inc., 136 Liberty St., New York City.

to almost the consistency of thin dough. Lay the plan out bottom up on a flat surface and apply the starch as a paint, thoroughly rubbing it into the surface. Keep the plan perfectly flat until dry and then it will be found that it will remain smooth. The flour starch will not injure the plan in any manner. This method was found to be the only successful way of treating a large number of old railroad plans which the writer had occasion to flatten out for filing in drawers.—Frank H. Jones, Winter Hill, Mass.



CEMENTED GRAVEL ON ST. PETERS CANAL, CAPE BRETON, N. S.—DIFFICULT "EARTH EXCAVATION" WITH A STEAM-SHOVEL

Difficult Steam-Shovel Excavation in "Earth"—The difficult digging a steam shovel is sometimes called on to do is well shown in the accompanying views of excavation on the St. Peters Canal, Cape Breton, Nova Scotia. The material is a glacial gravel very closely cemented into a hardpan. Under blasts it breaks down into the large pieces shown in the views, which are handled generally by the shovel in just that form, although occasional lumps have to be broken down by pot shots. The interesting feature is that the contractor, W. H. Weller, is required to classify this work as "earth excavation." He has appealed from the engineer's decision.

Track Foundations in Paved Streets—In "Engineering News," Nov. 26, 1914, there were reprinted sections of four types of track foundations recommended by the Committee on Way Matters of the American Electric Railway Engineering Association, at its recent convention. The Association desires to forestall any impression that this is its standard or recommended practice, since the Standards Committee did not approve the sections shown and the whole subject of track foundations was referred back for further consideration. In showing the construction in question, we were careful to note that the recommendation emanated only from the committee; nevertheless, we believed then, and do now, that the recommendations were of no little interest, in spite of the action of the Standards Committee, as they had back of them the weight of the Way Committee's experience and opinion.

Sounding Device for Well Tests—It is often difficult to ascertain accurately the water level in a well, especially if the well is undergoing a pumpage test by means of the air-lift system of pumping, for in that case only the annular space between the well casing and the eductor pipe is available for sounding purposes.

The device shown in the accompanying illustration was designed for overcoming this difficulty and has proved successful. It consists of a wooden rod, ⅞ in. in diameter and about 30 in. long, one end of which is weighted with lead so that the rod floats in a vertical position. A hole about 6 in. deep is bored into the upper end, serving as a guide for a short piece of brass rod, and also to contain a small amount of mercury.

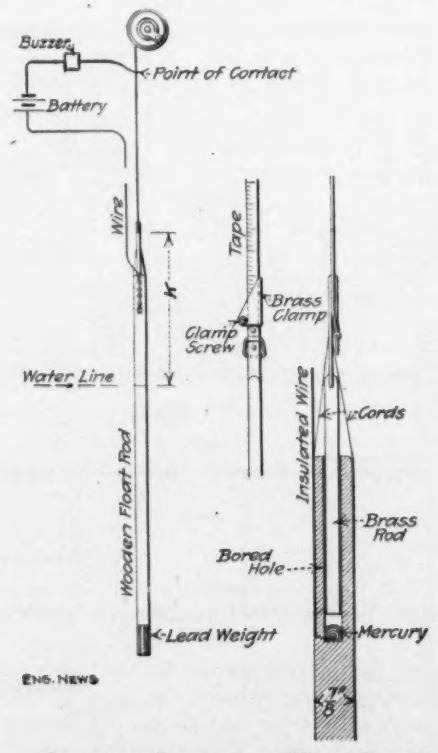
A copper wire projects through the side of the wooden rod into the mercury. This wire must be somewhat longer than the deepest sounding to be taken, and be well insulated. The brass rod terminates in a small clamp, made of sheet brass, to which a steel tape may be attached. The wooden float rod is hung from this clamp by means of two pieces of cord of such length that the end of the brass rod is a small distance above the surface of the mercury.

In operation, the copper wire is connected in circuit with a small dry battery and an electric buzzer; a loose end of wire held in contact with the steel tape completes the circuit except for the small gap between the end of the brass rod and the mercury.

When the wooden rod has reached the water level in the well and has become submerged sufficiently to float, its weight is taken off of the tape, a very slight additional lowering of which causes the brass rod to touch the mercury, thereby closing the circuit and sounding the buzzer.

A distance "K" from the water line of the float rod to the end of the tape must, of course, be added to the tape reading.

This device is also adapted to measure the depth of pits, etc., and with slight modification can be used for soundings. A convenient adjunct is a small electric light which can be lowered into the well to examine the casing, etc., above water level.—M. F. Stein, 419 City Hall, Cleveland, Ohio.



SOUNDING DEVICE FOR WELL TESTS
(Invented by Milton F. Stein, Cleveland, Ohio.)

Editorials

What Is the "Cost" of Service by a Municipal Electric-Light Plant?

The interesting question has recently been answered by the Massachusetts Gas and Electric Light Commissioners as to what "price" a municipally owned utility could legally make to private customers and to the municipality itself. The statutes require that the minimum price to private consumers shall not be less than "cost," including interest on investment, maturing debt requirements, and depreciation. A maximum price is fixed at "cost" plus 8% profit, "cost" in both cases evidently meaning an average figure distributed over all the current generated, and neglecting well known differences in the actual cost of serving different classes of customers. Prices of less than this "cost," however, may be fixed with the consent of the Gas and Electric Light Commissioners. A municipality is to be "charged at cost" for all current supplied to it.

It appears that the municipal electric-light plant of Reading, Mass., had been operating with a small deficit each year in providing for operation, interest, maturing debt and depreciation, which deficit has been met out of the tax funds. Naturally, a sharp local controversy arose as to whether certain rates for private heat and power were not too low, or the supply to the town itself were not below the "cost" required to be charged by statute. The Board of Gas and Electric Light Commissioners, being asked to review the situation, approved the existing private rates although some are below the average cost of the governing statute. It held that these prices cover the various true cost items in fair proportion, and that accordingly the town is properly "charged at cost" for what it uses, so long as the direct appropriation plus the deficit met out of general funds keeps the plant solvent. As to how the various departments should handle their bookkeeping, the commission disclaims jurisdiction.

Well Deserved Support of the Coast and Geodetic Survey

The U. S. Coast and Geodetic Survey is the oldest scientific bureau of the government service, but there has long been an unfortunate lack of appreciation of the public importance of this bureau's work, and for many years it has been obliged to get along with inadequate appropriations and very defective plant. The Survey has now had the good fortune to find in Secretary of Commerce Redfield and President Wilson strong supporters of its work.

Secretary Redfield, in his annual report, just issued, and in recent public addresses, has shown the difficulties under which the officers and men of this bureau are attempting to accomplish their tasks. To take but one example: Secretary Redfield states that three of the vessels used in the Coast Survey work are, respectively, 38, 39 and 52 years old, one of them having been built as a Confederate gunboat in 1862. They are so unsafe and so unsanitary that if they were owned and operated by private parties the Government's Steamboat Inspection Service might well condemn them on the ground of public safety and public health. In fact, Secretary Redfield declares these ships are so bad that no private owner would use them, yet these are the vessels which the Survey has to use to carry on its work on the stormy and dangerous coast of Alaska. As for the buildings in which the Survey is housed in Washington, the walls of some of them, after being twice condemned by the District of Columbia authorities, were shored up to keep them from falling, and the Public Health Service has recently condemned them because of their unsanitary condition.

High commendation is given by Secretary Redfield to the wire-drag system of making soundings, which has been used by the Survey in recent years and is being extended as rapidly as funds are provided. In the eight years since the wire-drag surveys began on the Atlantic coast, 3300 rocks with less water over them than the charts showed have been discovered by this method. Nearly 900 of these were distinct menaces to navigation.

It seems to us that there is here an opportunity for the engineering profession to make itself heard in support of a government engineering bureau whose work in accurate mapping, precise leveling and the charting of the coasts of the United States is of immediate interest to engineers everywhere. Secretary Redfield's report makes clear that this bureau is hampered in the performance of its work for public safety by lack of sufficient appropriations. The engineering societies of the United States might well reinforce the recommendations of Secretary Redfield and President Wilson by the passage of suitable resolutions appealing for ample appropriations by Congress for this most important division of the government's engineering work.

Concrete Surface Finishes and the Test of Time

The early treatment of the surfaces of concrete structures, where there was any treatment at all, was consistently a mortar wash over the board-marked surface of the concrete. With few exceptions, this surface rapidly deteriorated. The light finish sloughed off and left scabby patches anything but pleasing. With the development of concrete work, an effort was made to procure for concrete surfaces some degree of artistic merit which would have for an important secondary consideration a good wearing quality. The primary consideration of an initially good appearance was satisfied by a number of different methods, but sufficient time has hardly elapsed to get much evidence as to the permanency and extended wearing qualities of these surfaces.

Recently, however, the observation of a number of concrete structures of approximately ten years of age

has impressed upon us the extremely successful wear of two particular types of surfaces, one a bush-hammered surface crushed-granite concrete, and the other, the familiar scrubbed selected aggregate surface devised by H. H. Quimby when he was Engineer of Bridges of the City of Philadelphia, and applied by him to a number of the bridges in that city. All surfaces of the former type show that even after ten years of life the bush-hammered granitic concrete has as sharp and sparkling a face as the day it was made, and compares favorably with the surface of a natural granite. Precisely the same may be said of the Quimby surface on the Philadelphia bridges. Contrasted with the frequently scabby, pitted or stained condition of the old smooth concrete surface, the selected aggregate surfaces of the Philadelphia bridges are quite remarkable.

It is probable that some of the other methods of treatment are equally successful and possibly somewhat cheaper, but these two particular methods have been brought so strikingly to our attention as to appear to us to be worthy of commendation.

Railways Which Ought Not to Have Been Built

We noted in our issue of Nov. 5 the impending abandonment of the Buffalo & Susquehanna Ry. in western New York, on which the traffic was no longer sufficient, in the opinion of the owners, to make it worth while to continue operations. Since then, announcement has been made that a railway line in Iowa of considerable local importance is to be abandoned for similar reasons, and that the residents along the line of the road are appealing to the State Railway Commission to compel the company to continue its operations. There are undoubtedly many hundreds or thousands of miles of railway lines in the United States which ought never to have been constructed. They were built either at a time when exaggerated ideas prevailed as to the prospects of profit in railway operation, or in the days when railway competition was active and the paralleling of existing railways was a recognized and fairly reputable industry.

It is not generally known, however, that similar conditions have prevailed in European countries, and notwithstanding the barriers which have existed there against the speculative use of railway franchises. In the recent presidential address before the Institution of Civil Engineers, Benjamin Hall Blyth reviewed fifty years of railway construction in Scotland and gave some interesting illustrations of unprofitable railways which have been built in the Scotch Highlands.

The Invergarry & Fort Augustus Ry. was promoted in 1896. The line is 24 miles in length and was originally estimated to cost about $1,000,000, a little under $50,000 per mile. The actual cost, however, was much in excess of that sum. The company which built the railway leased it for operation, but there was so little traffic on the line that the leasing company finally refused to operate it and the road was for a time abandoned altogether. The local land owners finally secured the resumption of operations, and last year the company operating the road purchased it outright for $130,000, probably less than one-tenth of its original cost.

In 1897 three different companies appealed to Parliament for permission to build a railway from Fort Augustus to Inverness, about 34 miles, paralleling the Caledonia Canal. The estimated cost was from $1,800,000 to $2,700,000. All these bills were thrown out by Parliament. The district through which the line was projected is almost without population or production, and it is exceedingly doubtful now with motor cars available for land service and steamboats running on the Caledonia Canal whether the intervening gap between Fort Augustus and Inverness will ever be filled by a railway.

Another remarkable enterprise was the Paisley & Barrhead Ry. It was authorized by Parliament in 1897 and was finally completed and taken over by the Caledonian Ry. Co. From the day of its completion to the present not a single train has ever run over the line.

A Projected Concrete Toll Road for Automobiles in Texas

A century ago the building of toll roads by private companies was actively going on in many parts of the country. The coming of the railway diverted attention from highway construction, and after 1840 very few toll roads were constructed.

In recent years there has been a widespread movement for the condemnation and acquirement by the state of the few remaining toll roads owned by private companies. It is doubtful whether a toll road has been built in the United States in the last quarter century, unless such automobile speedways as the Long Island Motor Parkway, described in ENGINEERING NEWS, Sept. 17, 1914, be considered toll roads.

A project has just been launched in the State of Texas, under the authority of an act passed by the Texas legislature last year, for the building of concrete toll roads as a private enterprise. It may be of interest to discuss very briefly what are the general financial possibilities of such a scheme.

The cost of construction of such a road is estimated at $20,000 per mile. If we assume a width of 18 ft. and a cost of $1.25 per sq.yd. for the concrete paving, both of which figures should be adequate, this would give a cost of $13,200 per mile for the concrete alone, leaving $6800 per mile for right-of-way, grading, draining, fencing, bridging and all expenses in connection with the corporation. On the level plains of Texas and in a farming region where right-of-way could be secured at reasonable figures, this allowance would seem to be sufficient. In fact, it would be possible, under favorable conditions, to considerably reduce the cost.

Interest on the investment of $20,000 per mile at 6% would amount to $1200 per mile of road per year. The promoters claim that the concrete road, once well built, would cost nothing for maintenance if it were used exclusively by automobiles with rubber tires. It will be admitted that the maintenance of the road surface should be very small under such conditions, especially in the Texas climate, where the temperatures seldom fall very low and no trouble from frost attacking the foundations of the road need be feared. There would, however, be a certain expense for maintenance on other parts of the roadway, such as the bridges, ditches and other drains, for cutting weeds along the right-of-way, maintenance of fences, etc., and the wages of toll keepers. It would hardly be safe to figure on any smaller sum certainly than

$200 per mile per year. Some provision must be made also for a sinking fund to pay off eventually the bonds issued for the construction of the road, so if the road is to be a profitable commercial enterprise it must average earnings from tolls of at least $1500 per mile per annum.

The projectors of the Texas road propose a toll rate for automobiles of 1c. per mile and make the not unreasonable claim that an automobile owner will save at least 2c. per mile in gasoline, tires and general wear and tear on the machine, by running his car over a smooth concrete road compared with the ordinary Texas dirt road. They also propose a special tax on motor trucks according to the weight of freight carried.

It would seem not unreasonable to assume that an average toll rate of 2c. per mile on automobiles would be practicable, since a graduated tariff could be applied, charging a lower rate for the cheap small cars of the farmer and mechanic, and a considerably higher rate for the costly high-powered cars. The owners of the latter would be willing to pay a considerably higher price for the privilege of using a first-rate road.

If we assume an average toll rate of 2c. per mile, it would require an average traffic of 75,000 automobiles per annum to yield a revenue from tolls of $1500 per mile. This would be an average traffic of 206 cars per day, and if this traffic were evenly distributed throughout 12 hours of the day, it would be 17 cars per hour. Of course, there are many roads in the suburbs of large cities which have an automobile traffic very greatly in excess of this. Whether an average traffic of this amount could be counted on for an interurban road in Texas, such as is proposed by the promoters of the toll-road company above referred to, is a matter on which traffic counts in the locality should furnish fairly accurate information.

It will, of course, be apparent that such an enterprise would have far greater possibility of success in a state like Texas, where there are few roads outside of the cities which have paved surfaces of any sort. It must be borne in mind, also, that the use of automobiles is increasing to an amazing extent. The automobile registration in Texas in the years 1910 to 1913, inclusive, increased 452%, a greater percentage of increase than that of any other state of the Union except Kansas.

We are informed that the promoters of the Texas concrete toll road are reputable business men. The above analysis indicates that their project has at least a chance of yielding a return to those investing in it. It is to be hoped that the project may be carried into effect and that a practical demonstration may be given as to the possibilities of toll-road construction for automobile traffic.

A New Process for Improving Steel-Rail Manufacture

It has been known in railway circles for several months that the Lackawanna Steel Co. was developing a new process of treating steel rails during their manufacture, which it was claimed would effect a considerable improvement in the quality of the product. The company, however, has been hitherto unwilling to give out for publication any information concerning the nature of its new process. The first public statement concerning it is given in the paper by Capt. R. W. Hunt, just presented at the meeting of the American Society of Mechanical Engineers and printed in this issue.

The aim of the new process is to remove from the top and bottom surfaces of the billet which is ultimately to form the finished rail a skin of partially decarburized metal, containing blow holes and imperfections which were formed when the ingot was originally poured in the mold. These imperfections become longitudinal surface seams as the ingot is drawn down under the action of the rolls to a billet and finally to a finished rail.

The method by which this result is accomplished is something truly unique in mechanical engineering. The skin of metal is cut off the surface of the white-hot billet by a huge milling cutter running at a speed of 2500 ft. per minute, and cutting off metal at the rate of 500 to 800 cu.in. per minute. The removal of metal at this enormous rate is possible through the fact that the work is done upon metal so hot that it is in a plastic condition.

With the exception of the cutting-off saws in general use in rolling mills, there are very few cases that we recall where white-hot metal in a plastic condition has ever been subjected to cutting tools. From Captain Hunt's paper, however, it appears that the milling cutters used in the Lackawanna process are entirely durable, much more so in fact than they would be if used for cutting the metal cold.

Captain Hunt's commendation of the process is, of course, praise from a very high source. It will be evident that the new process has no effect on any interior defects in the ingot, such as piping or segregation, to which undoubtedly many rail fractures are traceable. There does seem good reason to believe, however, that the type of rail failures known as split heads and split flanges, which have been uncomfortably common in recent years, may be materially reduced, if not wholly eliminated, by the Lackawanna Steel Co.'s new process.

The Lesson of the Edison Fire

The disastrous fire which gutted a large part of Thomas A. Edison's manufacturing plant at West Orange, N. J., on December 9, was another of those catastrophes from which the engineering world increases its knowledge. The damage was so extensive and the clearing up since has been so active that it is difficult in the short time since the fire to get any account of the precise nature of the conflagration or any official statement of the losses, but an examination of the ruins is sufficient to make evident certain lessons that, doubtless, later thorough investigations will amplify.

First and foremost, the Edison fire emphasizes once again that most trite of fireproofing axioms—a non-burnable frame does not in itself constitute a fireproof building. To go to the expense of erecting many large and elaborate reinforced-concrete buildings, housing most inflammable materials and surrounded by wooden structures, and then to light those buildings with plain glass windows in wooden frames and to omit any automatic sprinkler or emergency water service can be excused only as an eccentricity of a genius whose transcendent ability in certain fields has in no wise made him omniscient. While the conflagration at its height was so severe as probably to make impotent all such precautions, a proper equipment with some such fundamental fire-protection appliances would have either prevented the initial spread of the fire or confined it to a comparatively limited area.

From a structural standpoint the lessons taught are

radically new. The gutted buildings in the plant demonstrate beyond contradiction that the column is the critical element in reinforced-concrete design. In every building, including those most seriously damaged, the remarkable toughness of the reinforced-concrete frame was evident. Utterly stripped by fire of all contents, window frames and floor coverings, the naked concrete frame is standing, in every instance but one, with only minor cracks in beam and slab and hardly a perceptible sag or lean except where the columns have given way. In all but two of the reinforced-concrete buildings a superficial examination indicates that, after washing out with a hose and placing new window sash and glass, the buildings will be ready for installation of equipment.

In the remaining two buildings the trouble without exception lies in the columns, which have buckled and broken in an unprecedented manner. The immunity of certain columns and the destruction of others is not easy to explain, although the degree of heat and the application of water may be responsible; but those columns which ha[ve] failed point decidedly to one conclusion—the straigh[t]-rodded reinforced-concrete column is dangerous in a h[ot] fire. The views and description of the columns on a[n]other page of this issue will make every concrete designe[r] pause and consider the possible ultimate economy, from [a] fire-resisting standpoint, of hooped reinforcement.

The Edison plant today is a field museum of reinforced concrete construction; it should be studied by everyone interested in the industry. Only after a thorough examination can a proper report be made on the conditions before and after the fire; and in the interest of good practice in concrete design, it is to be hoped that such study will be undertaken. Meanwhile, the observer must look at the wreck with mixed feelings: deep respect for the ability of the concrete frame to withstand the hard usage it received and wonder, not to say perplexity, at the manner of failure of some of the straight-rodded columns.

Letters to the Editor

The Low Headway on the New York Barge Canal as a Hindrance to Traffic

Sir—The writer accompanied the Atlantic Deeper Waterways Association on its excursion up the Hudson River on Sept. 25, and there for the first time learned that New York's new barge canal will have a clear headway of only 15½ ft. between the water surface and fixed bridges over it. This news gave the writer about as severe a shock as he ever experienced.

For years we have looked forward to the reopening of the modern Erie Canal, with the expectation that it would have some such favorable influence on transportation as the original Erie Canal in 1825. It was, therefore, a tremendous disappointment to learn how far below its anticipated effectiveness the Barge Canal would prove, with its limitation of dimensions of vessels.

It was humiliating to hear the Governor of New York and other prominent speakers, during the progress of the excursion up the Hudson, give eloquent assurances as to what would follow the opening of the new canal, when big steamers from the head of the Lakes would traverse the canal from Buffalo to Troy and Albany, and after going down the Hudson, reach out to other Atlantic seaports. In like manner we were treated to equally eloquent assertions that the vessels steaming up the Hudson would pass through the Erie Canal for delivery of return cargoes at various ports on the upper lakes.

Promptly, after my return to Philadelphia, it was demonstrated to our satisfaction that such barges as for years have traversed the Chesapeake & Delaware Canal, the Lake Drummond Canal and the Sounds of North Carolina, could not pass through the New York Barge Canal, either light, loaded, or partly loaded.

These barges carry loads of 835 tons cargo, drawing 9 ft., and 1000 tons on 10-ft. draft. The dimensions of these barges are substantially 210 ft. in length, 23 ft. 10 in. in width, and measure from bottom of flat keel to the top of the pilot house; steel barge, 30 ft., and wooden barge, 32 ft. The wooden barge when light is 13½ ft. and when loaded 6½ ft. too high to clear the bridges.

During the past season steamers carrying 320,000 bushels or more of wheat have left Duluth, Fort William and Port Arthur, passed through the Soo Canals and unloaded their cargo destined to Montreal, at Owen or Parry Sounds, or Port Colborne, Canada. At Owen Sound and Parry Sound the transportation unit is reduced to 1500 bushel "carload units," and forwarded by railroads to Montreal. At Port Colborne the wheat is transferred to smaller steamers carrying, say 80,000 bushels wheat, which proceed through the Welland and Lachine Canals to Montreal.

The improvements under way at the Welland Canal, at an estimated expenditure of $50,000,000, to be supplemented by harbor improvements at Toronto costing probably $10,000,000 more, when completed, will still farther improve the Canadian export routes.

From May 1 to Nov. 28, 1914, there were exported from Montreal, 60,000,000 bushels of wheat, while during the same period New York exported only 26,000,000 bushels.

Prompt action would seem imperative upon the United States and New York State authorities, to rectify, so far as possible, the minimizing factor of insufficient height of fixed structures throughout the length of the new Barge Canal, as at present constructed.

FRANK L. NEALL,
Manager Philadelphia Transportation Bureau.
Bourse Building, Philadelphia, Dec. 6, 1914.

The New York Alien Labor Law

Sir—In an editorial in your issue of Dec. 3, referring to the New York Alien Labor Law, the general implication was that the law was not a good one.

I think you have overlooked the real intent of the law—that it is not its purpose to protect the public interest of New York, but to protect the interests of the American laborer, both skilled and unskilled. When aliens are entering the port of New York at the rate of a million a year, the enforcement of a law of this sort is necessary. Foreigners can get employment and live comfortably (according to their standards) when a native cannot live at all because his higher civilization exacts a higher standard of living. Under these conditions the American workman cannot survive—he simply disappears in the struggle for existence. No contractor can pay the American union rate without financial failure, where his competitors are paying aliens one-half to two-thirds as much. And with unrestricted immigration, this means that either our workman must be protected by legislation or else disappear from the industries.

To me it seems criminal to do anything in opposition to this law, which is only a last attempt on the part of the American workman to keep his footing in his own land.

A. W. BEDELL.

Chappaqua, New York, Dec. 10, 1914.

[A careful rereading of the editorial referred to will show that we did not discuss in it the merits or demerits of the Alien Labor Law. The purport of our editorial was to show the enormous public loss which would result were there to be a wholesale annulment of the subway contracts because of past infractions of the law. We urged also that the status of the law should be promptly settled and it should then be either enforced or repealed.—ED.]

Paint Protection of the Panama Canal Lockgates

Sir—My attention has been directed to an article in your issue of Nov. 26, on "Experience with Paint on the Panama Canal Lockgates," in which you refer to the poor results obtained with the paint applied to these gates.

It seems proper to point out that the unsatisfactory results mentioned in Col. Goethal's report refer entirely to the *exterior* surfaces of the gates, especially to that portion permanently under water. All *interior* surfaces, which comprise three-quarters of the total area, have remained perfectly protected, although in both the air and water chambers the conditions are rather more severe than on the outside of the gates. These surfaces were not painted in the usual manner, but were treated with a bituminous compound applied in a hot, molten condition to the clean metal.

Coatings of this kind, under the trade names of "Bitumastic" or "Bitulithic" enamels, have long been used in the bilges of war and merchant ships and have given excellent results in difficult locations where ordinary paints fail. It was, therefore, thought, although they are very expensive, that the use of such enamels would be fully justified for the interior compartments of the lockgates, which are dark and difficult of access so that proper inspection and repainting are not easy.

In accordance with the writer's recommendation, the contract for the construction of the gates provided that their entire interior should receive two coats of a bituminous compound of this kind.

Before the material left the contractor's works at Pittsburgh, all the surfaces were cleaned by a sandblast or by pickling, and those parts that would ultimately form the inner surfaces in the gates received a coat of bitumastic "solution" applied cold like any other paint. After the gates were fully erected in the locks, a second coat of the cold "solution" was applied, and before this had become thoroughly dry a heavy coating of the hot "enamel" $\frac{1}{16}$ to $\frac{1}{8}$ in. thick was finally brushed on. It is understood that up to the present time all these interior surfaces remain in perfect condition in both the air and water chambers.

At the time that the contract for the Panama Gates was let, it was feared that difficulties might be encountered in applying the hot coating successfully to the large exterior vertical surfaces on the gates. Experiments made under the writer's direction since then at Panama and also by others elsewhere lead him to believe that this fear was unwarranted and that it would have been better to treat the exterior surfaces in exactly the same way as the interior, or at least those parts of the outside which are permanently under water.

While they are probably too expensive for general use, it is believed that compounds of the character described above offer the best means now available for protecting metalwork under especially trying conditions.

The painting of lockgates to protect them from corrosion is a problem which has not yet been satisfactorily solved. It is important to secure good protection at all times without frequent repainting, as this interferes seriously with the operation of the locks, especially in warm climates, where the operation is continuous during the whole year.

Apparently, no one paint has given perfect satisfaction, as at different places various kinds are found in use. Thus, in the Naval Dockyard at Plymouth, England, the writer in 1908 found a preference for a coal-tar paint of simple character, applied in numerous very thin coats, while in the new docks at Bristol, only a few miles away, red lead was exclusively used. It is understood that in the Sault Ste. Marie locks, where steel gates have been in use since 1895, no one paint has been found entirely satisfactory, although many different kinds have been tried.

The conditions of the water in the Panama locks are especially severe, owing to the large amount of vegetable matters contained in the water, which generate sulphuretted hydrogen, carbonic acid gas, and various vegetable acids. The same conditions, perhaps to an even more marked degree, prevail in other tropical rivers, such as the rivers of British Guiana, where it has proved very difficult to protect ships' bottoms and other metalwork.

The writer has always felt that for such waters the selection of a satisfactory paint, which should not be too expensive, would require a rather long period of trial.

HENRY GOLDMARK,
Late Designing Engineer, Panama Canal.
103 Park Ave., New York City, Dec. 7, 1914.

NOTES AND QUERIES

We published on p. 1160 of our issue of Dec. 10 reports of rail breakages on various railways. After that issue went to press we received additional figures from a railway company controlling 6000 miles of road. On this system during the 20 months from January, 1913, to August, 1914, there were 1891 broken rails and 17 train accidents caused by broken rails, of which 15 occurred during the winter months. Of the 1891 rails broken, 230 were 90-lb. and 1661 were 85-lb. rails.

The Mechanical Elimination of Seams in Steel Rails and Other Steel Products*

By Robert W. Hunt†

No part of railway maintenance has been given more discussion and greater publicity than steel rails. The question of safety to human life and limb, to say noth-

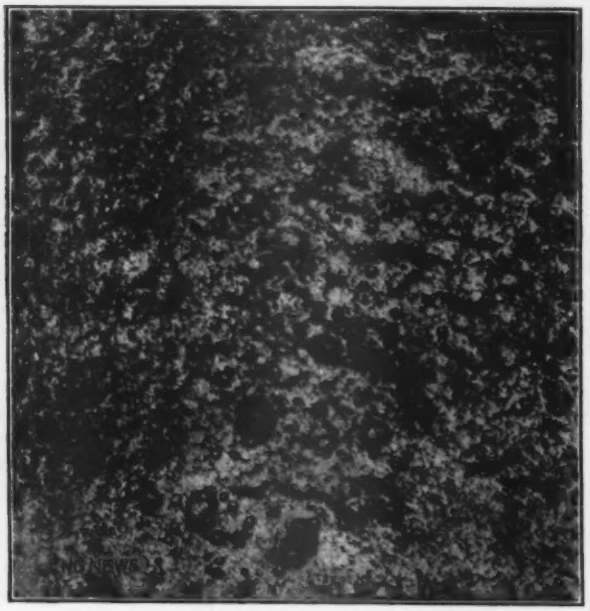


Fig. 1. Part of the Face of a Steel Ingot, Full Size, Showing Surface Imperfections

ing of property, is so dependent upon the quality of rails, that the reason for this publicity is easily understood.

Increased weight of rolling stock and speed of traffic have necessitated increasing the size of the rail sections, and hence their weight; and as many of the details of rail manufacture have been changed with such alterations, it is not surprising that new and unexpected physical weaknesses developed in the heavier rails. One of the most notable was failure through crescent-shaped pieces breaking out of the rail flanges, followed by at least one, and in many cases several, ruptures across the whole section of the rail. Investigation showed that in practically every instance of such failure there was a more or less pronounced seam running longitudinally in the bottom of the rail near its center, and thus immediately under its web. This seam occurs at the top of the curve of the crescent-shaped break and is undoubtedly the point at which the fracture starts.

Those familiar with steel-rail making knew that it was practically impossible to make rails entirely free from seams, and that as the seamy condition of the steel forming the head of the rail increased, so would its wearing quality decrease, but I think it was not until the disastrous experiences with the "moon-shaped" failures that the danger from seams in the base of the rails was fully realized.

The crescent-shaped breaks were of such frequent occurrence that they led rail makers to experiment with the design of their rolling passes with a view to obviating the formation of the bottom seams. Fewer seams were produced as a result of such changes, but they were not entirely eliminated. While more or less successful in preventing the formation of seams through lapping on the bottom of the rails, the formation of seams in other parts of the section was not particularly affected.

It is a well known fact that it is not alone the quality of rails which deteriorates through the use of seamy steel, and the fundamental causes in one will more or less apply to all cases. T. H. Mathias, assistant general superintendent of the Lackawanna Steel Co., determined that the most certain way of getting rid of seams was to remove that portion of the metal which contained them, and, as applied to steel rails, thus to eliminate them from both the base and head of the rail. This was a reasonable assumption, but its execution, I think, would have seemed very impracticable to the minds of most metallurgical engineers.

Mr. Mathias reasoned that the primary causes of seams existed previous to any rolling of the steel, in fact, were incident to the casting of the molten metal into ingots. He knew that disk-like apertures were formed on the sides of ingots while the molten metal was being cast and were probably caused from air being entrapped against the sides of the ingot molds by the hot steel as it rises in the molds. This condition is illustrated by Fig. 1 which represents a section of the face of such an ingot, actual size, and illustrates how serious such apertures may be.

It will be appreciated that, as the section of the ingot

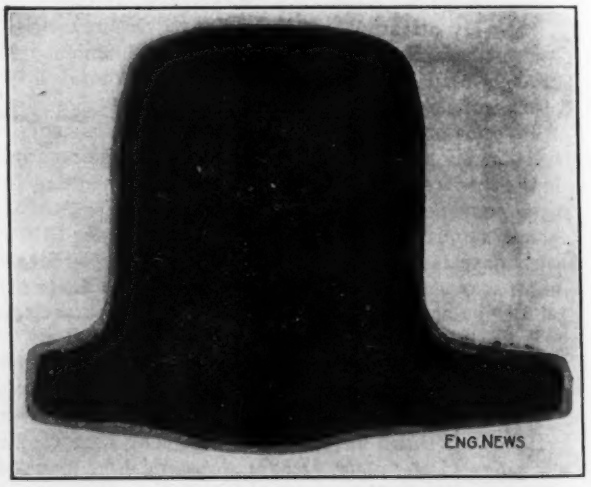


Fig. 2. Cross-Section of Bar for a Steel Rail Polished and Etched to Show Low-Carbon Metal on Exterior

is reduced and elongated in the rolling process, the apertures will be stretched longitudinally and thus be formed into seams.

Mr. Mathias further demonstrated that in the handling of large steel ingots a decarburized surface is formed on all of their four faces, about $\frac{5}{16}$ in. deep, and containing from eight to ten points lower carbon than the metal

*From a paper read at the annual meeting of the American Society of Mechanical Engineers.

†President, Robert W. Hunt & Co., Insurance Exchange Building, Chicago.

immediately under it, the decarburized envelope undoubtedly being produced through the oxidizing conditions to which ingots are subjected in the soaking pits where they are heated preparatory to rolling. A thick oxide scale is always formed on the surface of ingots in the pits, so that

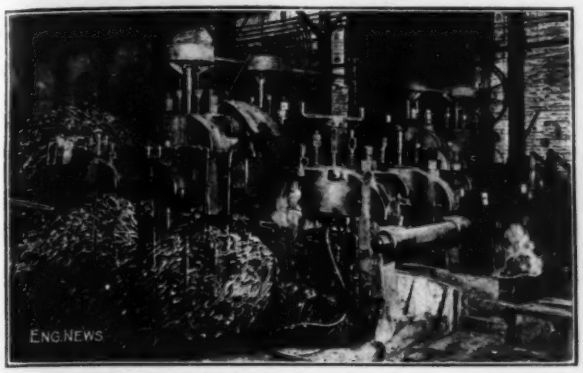


FIG. 3. MATHIAS HOT SAW IN LACKAWANNA RAIL MILLS, PLANING METAL FROM TOP AND BOTTOM OF RAIL BLOOM

conditions are invariably present for the production of such a layer of lower-carbon metal on their outside faces. Fig. 2 illustrates the presence of this lower-carbon envelope or skin. It shows a polished and etched cross-section of a part of an ingot which has been heated to a rolling temperature in the soaking pits and has been reduced by five passes through the roughing rolls.

Mr. Mathias was convinced that during the process of rolling ingots into rails it was practical to remove mechanically the parts of the enveloping steel which would form the top of the head and bottom of the flange of the rail, and he experimented accordingly. He designed and his company installed as an addition to their rail train, a milling, or a hot sawing machine, as I believe Mr. Mathias designates it, to cut off this layer of lower-carbon metal without retarding the regular operation and thus interfering with the production of the mill. This is illustrated by Fig. 3, which is a photograph of the machine in operation. The machine is located in echelon in relation to the rest of the rail train.

The ingot is reduced in the blooming rolls to an 8x8-in. cross-section; and after cropping the ends, the bloom is further reduced in the roughing or shaping stand of rolls by five passes. When it leaves these rolls, it is approximately 75% finished, and at this period it is carried to the right and entered between two pinch rolls with its base or flange side up. A bar which will make four 33-ft. rails is at this point in the rolling operation about 60 ft. in length; therefore, the area of metal to be cut off or removed in the milling machine is approximately $\frac{1}{8}$ in. deep, 7 in. wide and 60 ft. long. It is driven through the pinch rolls at a rate of 60 ft. in 30 seconds. The pinch rolls have a draft of about $\frac{3}{8}$ in. and thus force the bar between the two milling saws, which are so arranged in the housing that they may be raised or lowered as desired. There is from $\frac{1}{32}$ to $\frac{3}{64}$ in. of metal milled from the head and base of the bar, the front end of which, immediately on passing from between the rolls, is caught by a second set of pinch rolls which have a draft of about $\frac{1}{16}$ in. These pinch rolls force the bar between the tools, pull it from between them, and also hold it in practically perfect line for the milling operation. The milling apparatus is driven electrically and requires about 600 hp. for its operation.

As the milled dust or particles of steel are thrown out, they are hit by water under pressure which forces them into a chute and also prevents the material from adhering together. By the chute they are carried below the mill and caught in boxes or receptacles suitable for charging as scrap into the openhearth furnaces.

Fig. 4 shows the accumulated material removed by the hot saw which, as will be seen, is in regular openhearth furnace charging boxes.

Fig. 5 shows one of the milling tools. It is 5 ft. in diameter with an 8-in. width of face and revolves at a peripheral speed of 2500 ft. per minute, thus causing an engagement of about 400,000 teeth per minute on the hot rail bar. The teeth are of 0.80 carbon steel, and it has been demonstrated that they will mill at least 30,000 tons of material without requiring dressing. The one shown had milled about 15,000 tons.

The work of rolling which the steel receives after the removal of the more or less laminated metal must produce a better product than if such elimination had not taken

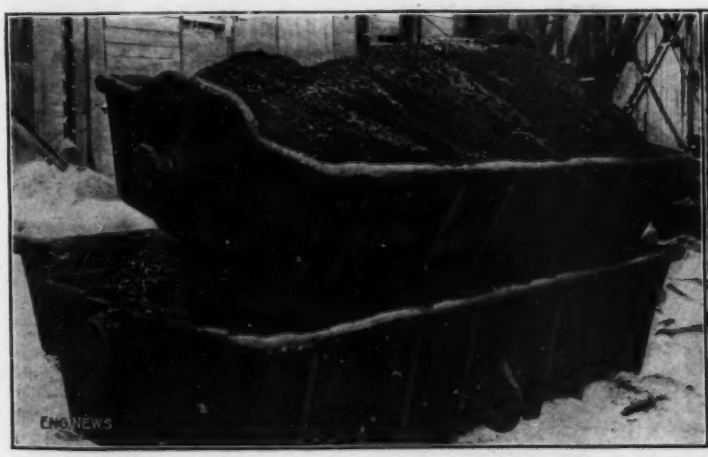


FIG. 4. STEEL CUTTINGS REMOVED BY HOT SAW

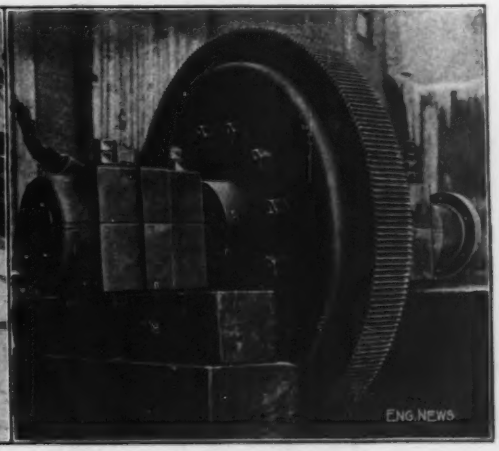


FIG. 5. MILLING CUTTER USED IN HOT-SAW MACHINE

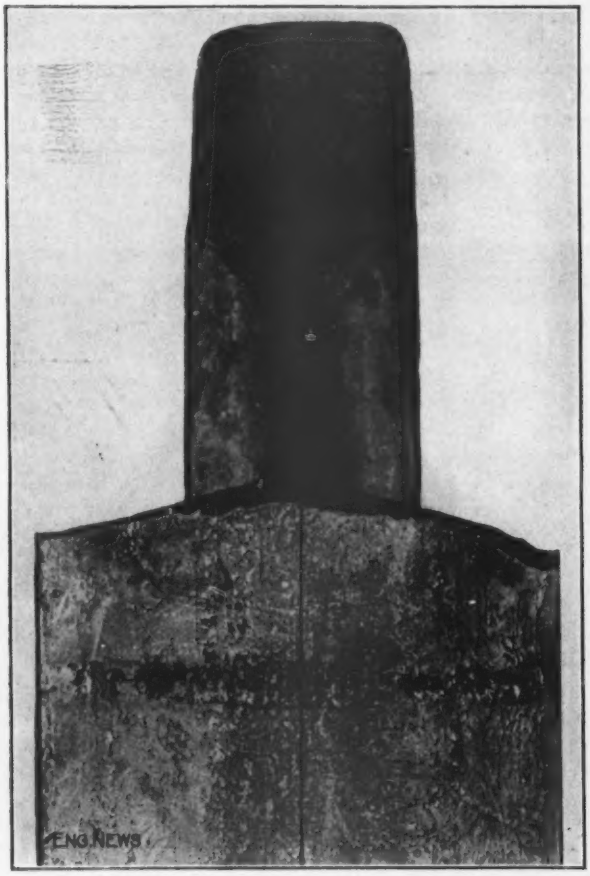


FIG. 6. STEEL RAIL BROKEN IN DROP TEST, SHOWING LONGITUDINAL SEAM IN CENTER OF BASE

place, and, in the case of steel rails, it should not only make them less liable to breakage on account of seams in their flanges, but also enable them better to resist the abrasive effects of traffic.

During the many years of my connection with rail making I have examined a great many etched specimens of rails, not only directly in connection with the process under consideration, but for various other reasons. From such experience I can fully appreciate what Mr. Mathias has accomplished. The surfaces of practically all rails, when etched, will show some seams on both base and head, and very frequently the extent of such defects will not be appreciated if the scale has not been removed. Even then, it is not always an easy or certain matter to estimate the depth of the seams. When the rails have been subjected to the Mathias milling operation and still show pronounced seams, it has been found that breaking tests will practically always develop the fact that the suspicious marking is an actual seam.

Fig. 6, which is a piece of rail broken under the drop press, plainly shows a pronounced seam in its flange directly under the center of its base, and is an illustration of a dangerous rail. As the original defects on the sides of the ingots vary in extent, so will the character of the resulting seams vary and it can be readily appreciated that some of them may have been too deep to have been completely eliminated by the milling.

To illustrate the appearance of many ordinary steel rails, Fig. 7 shows the surfaces of both heads and flanges. These specimens were taken from rails made by several different makers, including the Lackawanna Steel Co. These illustrations not only clearly show the field for such an operation as I have described, but also the extent to which Mr. Mathias has been able to accomplish it.

While I have confined myself to the matter of steel rails, it is patent that the process will be of great value in

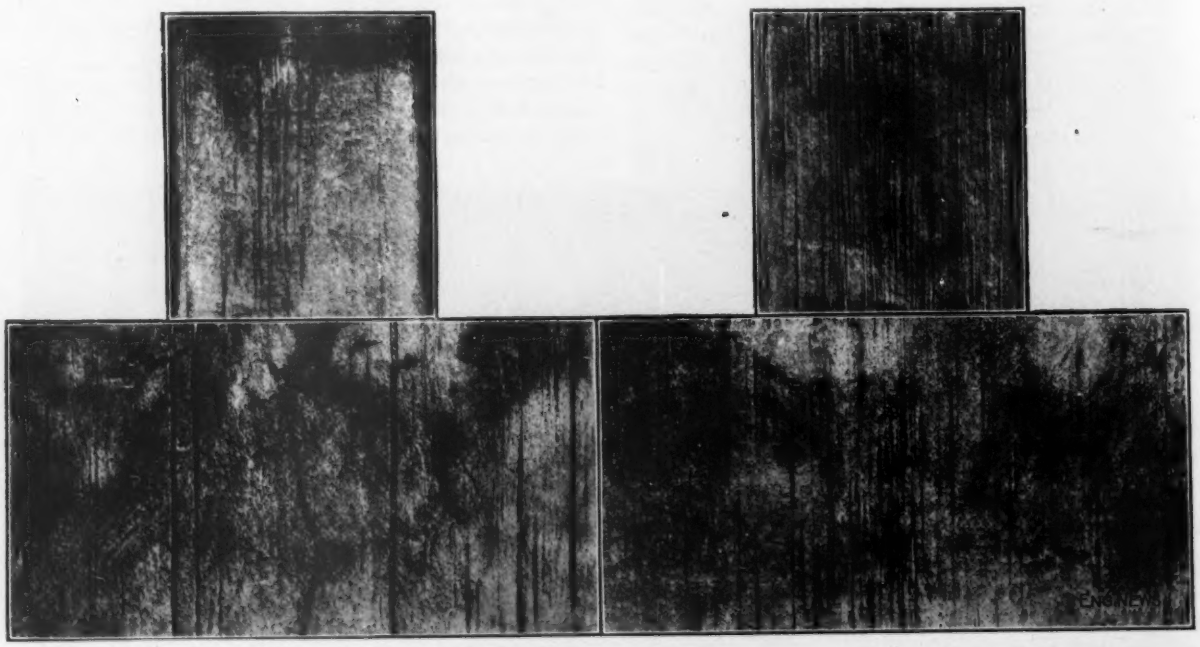


FIG. 7. EXAMPLES OF SURFACES OF RAIL BASES AND HEADS ETCHED TO SHOW LONGITUDINAL SEAMS

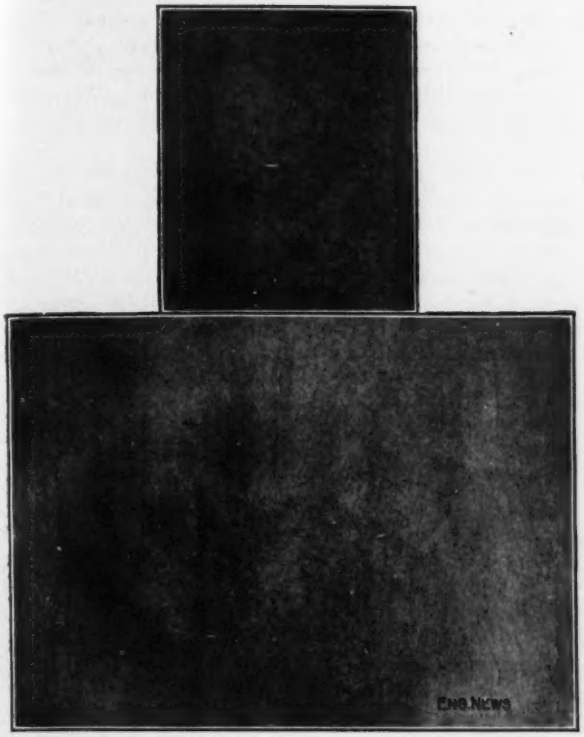


FIG. 8. SURFACE OF RAIL BASE AND HEAD TREATED BY LACKAWANNA DESEAMING PROCESS

the preparation of blooms for axles and all other kinds of forgings. As is well known, it is practically the universal custom to endeavor to remove the seams developed in rolling axle billets by chipping them out through the use of pneumatic hammers, and for some of the higher characters of forgings, notably for automobile parts, the endeavor to eliminate the seams is carried to the extent of turning off the whole surface of the billets. I am confident that by the Mathias plan the greater part, if not all, of such work can be superseded, and I regard the invention and its practical installation as a notable achievement in the art.

Flood Protection in China; Report of the Board of Engineers

The report of the Board of Engineers appointed by the American National Red Cross in May last to investigate projects for flood protection on the great plain of eastern China, has just been made public. In our issues of Sept. 25, 1913, and Feb. 12, 1914, we described the plans for control of the Huai River developed by Chas. D. Jameson, an American engineer long resident in China, and later the connection of the J. G. White Engineering Corporation with the project.

The report of the Board of Engineers just issued describes the unusual topographical conditions which have made the great plain of China at once one of the most fertile and densely populated regions on the face of the globe and likewise the greatest sufferer from alternate floods and drought. While the average annual rainfall over this area is approximately 36 in., it is subject to torrential rains of extraordinary severity. Local rainfalls of 25 in. in 48 hr. have been recorded, and storms of 4 to 8 in. in one to three days are quite frequent. The Huai River has not slope enough in crossing this plain to excavate for itself a deep channel, and it has in historic times frequently changed its course, thereby bringing calamity to millions of people.

The Board of Engineers in its report gives full credit to Mr. Jameson for the surveys and investigations carried on under his direction, but much more data are needed for the preparation of a final project. From such data as are now available, however, the Board is unable to recommend any of the projects heretofore suggested, and outlines instead a project of its own.

The Board's project involves the diversion of the Huai River where it enters Hungtse Lake and drainage of the bed of the latter, thereby reclaiming 400,000 acres of excellent land. The Board further proposes a system of control works and locks for the waterways affected, so that the channels it proposes to create and improve would be benefited for navigation and irrigation, as well as for flood prevention.

It is estimated that the entire work included in the Board's project would require the excavation of about 375,000,000 cu.yd. of material, or an amount 50% greater than the volume of excavation for the Panama Canal. The material to be excavated on the Chinese plain is nearly all earth, however, and the labor is phenomenally cheap. The total cost, including the proposed locks and controlling works, is estimated at $30,000,000. The direct benefits to the lands affected, estimated at over 7,000,000 acres, are appraised at $48,350,000. The members of the Board were Col. Wm. L. Sibert, Corps of Engineers, U. S. A., Prof. Daniel W. Mead, of the University of Wisconsin, and Arthur P. Davis, Chief Engineer of the U. S. Reclamation Service.

Annual Meeting of the Society of Naval Architects and Marine Engineers

The 22nd general meeting of the Society of Naval Architects and Marine Engineers was held at the Engineering Societies Building, New York City, Dec. 10-11. In the absence of Colonel Thompson, on account of illness, Stevenson Taylor read the presidential address. He called attention to the increase in the number of commercial seagoing vessels equipped with Diesel or other oil engines. The largest installation is 4000 hp. (six cylinders on each of two shafts), and more than 100 oil installations are in service at sea. Attention was directed also to the development in the geared-turbine system of propulsion. The number of such installations in service at present, or under way, is 126, amounting to 1,000,000 hp. During the past year 620,000 hp. in such turbines have been ordered. The submarine has undergone great development also. The modern type can steam at 20 knots on the surface and develop 5000 hp. with a combination of boilers, oil fuel and turbine-geared machinery. Storage batteries are employed for submerged driving. Several of the 14 interesting papers presented are abstracted below:

"Safety of Life from Fire at Sea," by W. O. Teague, listed a number of typical marine fires and their causes.

Means of prevention were then discussed, of which the two most important were the use of non-combustible material in the construction of the vessel, and automatic sprinklers. The use of steam for extinguishing purposes has not proved an unqualified success. Tests have been made on shore where combustible materials were completely burned although inclosed in an atmosphere of steam. Furthermore, steam will damage a valuable cargo as much as will water and is very wasteful. Furthermore, as it is applied only to holds, it is at best only a partial protection.

Inert gases* are good fire-extinguishing agents when the blaze is confined; but they are not as effective as water in absorbing heat, and have little cooling effect on the fire.

The use of carbon dioxide is objectionable since it causes asphyxiation. A 40-lb. tube is required to each 1000 cu.ft. of air space. The gas is not injurious to merchandise.

Stress was laid upon the value of automatic sprinklers, whose application to vessels has only just begun. The estimated cost of a sprinkler equipment on shipboard, exclusive of pumps and tanks, is about $4 per sprinkler, these being spaced about 10 ft. apart, each one protecting 100 sq.ft.

"The Stability of Vessels as Affected by Damage Due to Collision," by William Gatewood, discussed the best design to give both stability and comfort. He stated that:

> passengers prefer a vessel with a long period of roll, as the discomfort is much reduced thereby. To obtain a long period, it is necessary to have a large vessel or a small metacentric height; and the combination of the two requisites in the large Atlantic liners renders travel on them a pleasure instead of a bugbear to the landsman with a "sympathetic" stomach. If the small metacentric height is accompanied by a high freeboard and a considerable range of stability, there is small danger of capsizing due to wind and wave while intact. This comfortable condition of a vessel, however, may be a source of great danger even in still water if the vessel is damaged by collision.

"Refueling Warships at Sea," by Spencer Miller, interestingly described the gradual development in methods of putting coal and oil on board ship in a seaway. The value of doing this rapidly and safely was illustrated by a number of instances in marine operations during the present war. Attention was called to the record performance with the U. S. S. "Wyoming," coaled at Guantanamo Bay in the spring of 1914 from the U. S. collier "Jason" on one side and the "Nereus" on the other. In 9½ hours 2060 tons of coal were taken on and stowed—an average of 217 tons per hour. The colliers rigged out eight booms over the deck of the "Wyoming" and discharged with clamshell buckets.

The marine cableway, as being the most efficient method of refueling ships in a seaway, was fully described. The U. S. collier "Cyclops" illustrates the highest development in this direction. The cableway of this vessel is operated by three automatic tension engines—a new marine implement. Such an engine contains a novel form of tension governor, whereby the slightest change in the tension of the suspended cable produces a corresponding and proportionate change in the steam pressure. A slackening of the suspended cable produces an instantaneous rise in the steam pressure sufficient to restore the tension to normal; while a tightening of the cable produces an immediate reduction in the steam pressure, permitting the cable to pay out until the tension is restored to normal. This cableway has been tested in heavy seas, with the "Cyclops" rolling 20°. On another occasion coaling was carried on between the collier "Vestal" and the battleship "Virginia" in a dense fog, in which neither ship could see any part of the other.

"The Behavior of Riveted Joints under Stresses," by James E. Howard, called attention to the fact that few, if any, riveted structures are erected which are free locally from strains which exceed the elastic limit of the material. The structures are not necessarily endangered by the presence of these overstrains. It depends upon the character of the work which they have to perform, however, whether ultimate failure will result and the place of rupture be located by an overstrained zone. The strength of various kinds of riveted joints was then discussed.

"The Applicability of Electrical Propulsion to Battleships, together with the Experience Gained with it on the 'Jupiter,'" by Lieut. S. M. Robinson, U. S. N., was a paper whose presentation was awaited with great interest by the membership. The author stated that "I do not believe there is any question of the relative economy of the two methods—the electric drive is far superior. The 'Jupiter' was in commission over a year and a half, during which time two official trials were conducted, and the usual routine work of a navy collier carried on. She covered about 14,000 miles, and was handled around docks, in narrow channels, and in other places demanding flexibility of drive. About one-half of the steaming was done in the tropics, with circulating water over 80° F. and correspondingly poor vacuum, so that the economy of the ship is known under all conditions. The fuel economy was excellent, being on the average about 25% better than the best of her sister colliers."

The annual banquet was held in the Astor gallery of the Waldorf Astoria, on Dec. 11. The attendance was about 260.

In the election of officers for the ensuing year, the following were elected vice-presidents: Rear-Admiral W. L. Capps, retired; W. I. Babcock, W. S. Durand, and D. W. Taylor. Members of the Council elected were: J. E. Denton, D. H. Cox, H. L. Ferguson, C. H. Peabody, F. L. DuBosque, H. C. Sadler, H. S. Grove, and H. L. Aldrich. D. H. Cox was reëlected Secretary.

Sewers as Obstructions to the Chicago River, crossing the west fork of the South Branch of the river at grade instead of passing under the channel, are objected to in a suit brought against the Sanitary District of Chicago and the contractor by taxpayers affected by these obstructions to the channel. The contract provides for a concrete sewer crossing the west fork at So. 52d Ave. and at 39th St. near So. 56th Ave.; the sewer will be of horseshoe section 12x16 ft. at the first point and 10½ ft. diameter at the second. The complaint sets forth that instead of carrying the sewer under the channel by inverted siphons, the channel is to be carried under the sewer by culverts (four small openings at 39th St. and two larger openings at So. 52d Ave.). These, it is claimed, are liable to be choked by silt, débris and ice, causing the water to back up and overflow adjacent land. The complaint is made on the theory that the west fork is a navigable waterway, and points out that no permit for the obstruction has been obtained from the War Department or from the Illinois Rivers and Lakes Commission. This part of the West Fork, however, is an unimportant stream, ending in the old Ogden Ditch. It is paralleled by the Chicago main drainage canal, so that it may be considered quite negligible as a future navigable waterway, although the complaint is based on the idea of its possible development as a dock bordered by industrial plants which might thus have direct shipping facilities.

*The use of inert gases for extinguishing fires was fully described and discussed in an article and an editorial in "Engineering News," Dec. 18, 1913, p. 1235 and p. 1246.

The Fire in the Edison Works at West Orange, N. J.

During the night of Dec. 9, 1914, fire in the main plant of Thomas A. Edison, Inc., and associated companies at West Orange, N. J., very seriously damaged eleven buildings and burned over an area of nearly 6 acres in which these and other buildings were located. Estimates of loss run all the way from $750,000 to $3,000,000, the correct figure being largely dependent on the amount of reclamation of machinery and structure. Outside insurance was held to the amount of about $200,000. Only one person was killed, although a number of work people had to get out of the plant after the fire started and men were engaged all during the fire saving equipment and products.

FIG. 1. LOOKING SOUTHEAST OVER THE BURNED AREA OF THE EDISON PLANT WHERE THE FIRE STARTED
(Concrete building in left background is the phonograph building, where the columns, shown in Fig. 3, were all shivered.)

The plant comprised a great number of closely spaced buildings, separated by narrow interior streets and alleys and by the wider streets of the city. Structural design varied with the age of the buildings. The earlier buildings were one- and two-story structures with brick walls and timber floors, and in one or two cases steel roof trusses. About seven years ago reinforced-concrete buildings were started and this type of construction has been followed since.

The fire started in one of the low brick and timber buildings, probably from an explosion or rapid combustion of some of the elements of moving-picture film manufacture, and rapidly spread to the immediately adjacent low brick shops and storage houses. The contents of these proved such effective fuel that the fire soon spread into and through the reinforced-concrete buildings which housed film stock, phonograph cases, phonograph disks and cylinders, packing boxes and office records, all except the latter being highly inflammable. The fire started at 5:30 p.m. and was fought all through the night by the united fire departments of West Orange and the surrounding communities, but with the exception of the saving of the famous Edison laboratory (brick and timber buildings) and one concrete building alongside, all that the firemen could do was to prevent the fire from jumping a city street to the newest concrete buildings of the plant, those used for storage-battery manufacture. The fire was thus confined to buildings in a city block. It was not under control until the early morning of Dec. 10.

Water supply, practically entirely from the city service, was low in amount and pressure, though the severity of the fire and rapidity of its spread were such that probably this inadequacy had no effect on the final result. Of the entire plant only the laboratories were equipped with sprinklers, and the fire never came near enough to them to require the sprinkler service.

The reinforced-concrete buildings varied in height from four to seven stories and were all, with one exception, of the same general type, though varying somewhat in design and layout. In general, they had beam-and-slab floors spanning square, straight-rodded columns, with fascia wall girders holding wooden window frames with plain-glass lights. The exception was one of the older buildings, which had, for the lower floors at least, hooped round reinforced-concrete columns. The ends of some of the concrete buildings nearest the low brick buildings had concrete curtain walls instead of windows.

The effect of the fire on the brick and timber buildings has nothing of novelty; the view in Fig. 1, overlooking the site of the initial fire, shows the complete destruction wrought

The effect on the concrete buildings, on the other hand, is interesting in the extreme. Every concrete building

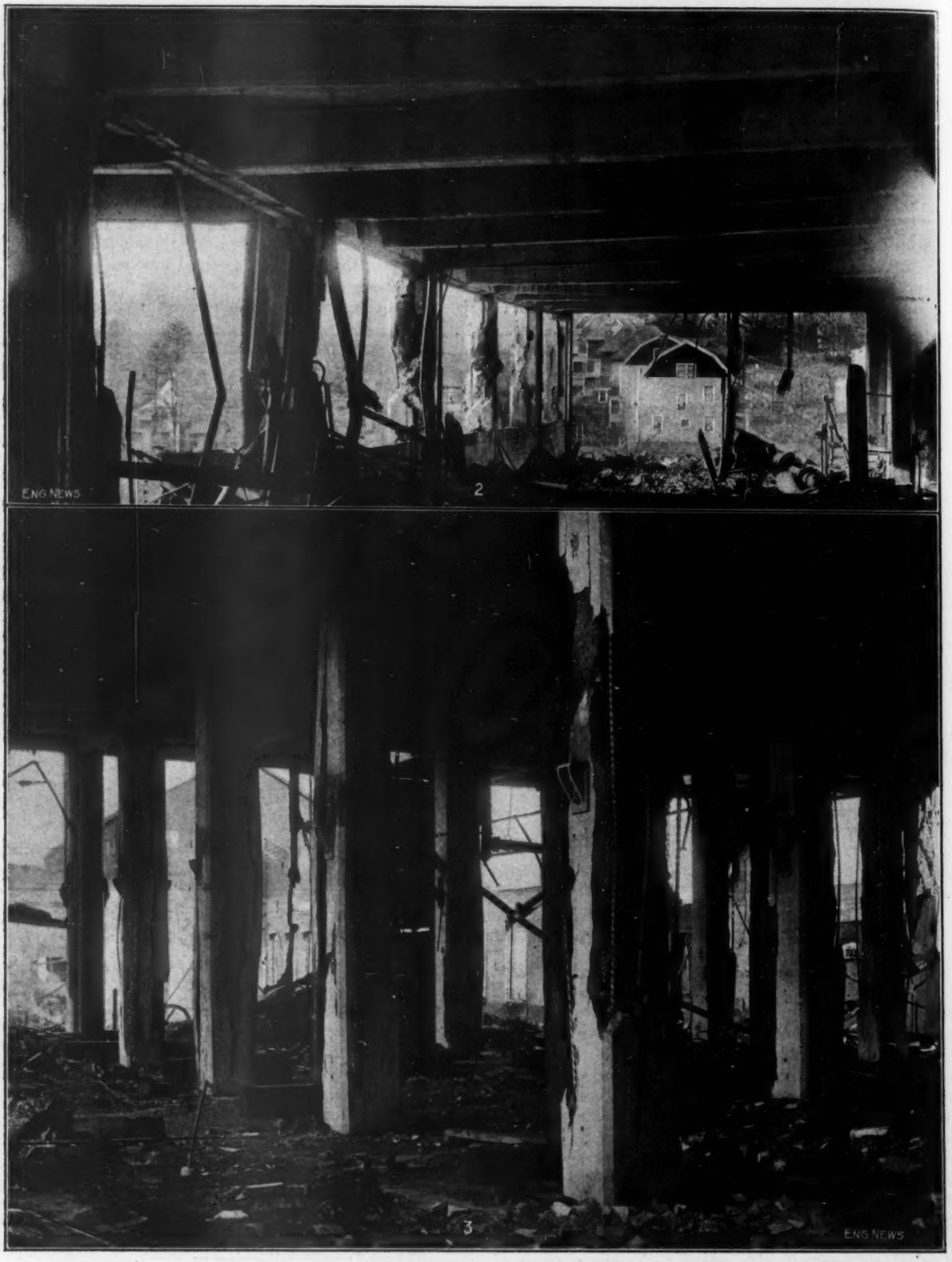


FIG. 2. THE THIRD FLOOR OF THE DICTATING RECORD BUILDING
(The outside of this building is shown in Fig. 3.)

FIG. 3. INTERIOR OF THE PHONOGRAPH STORAGE BUILDING, SHOWING COLUMN DESTRUCTION
(This building is the one shown in the left background of Fig. 1.)

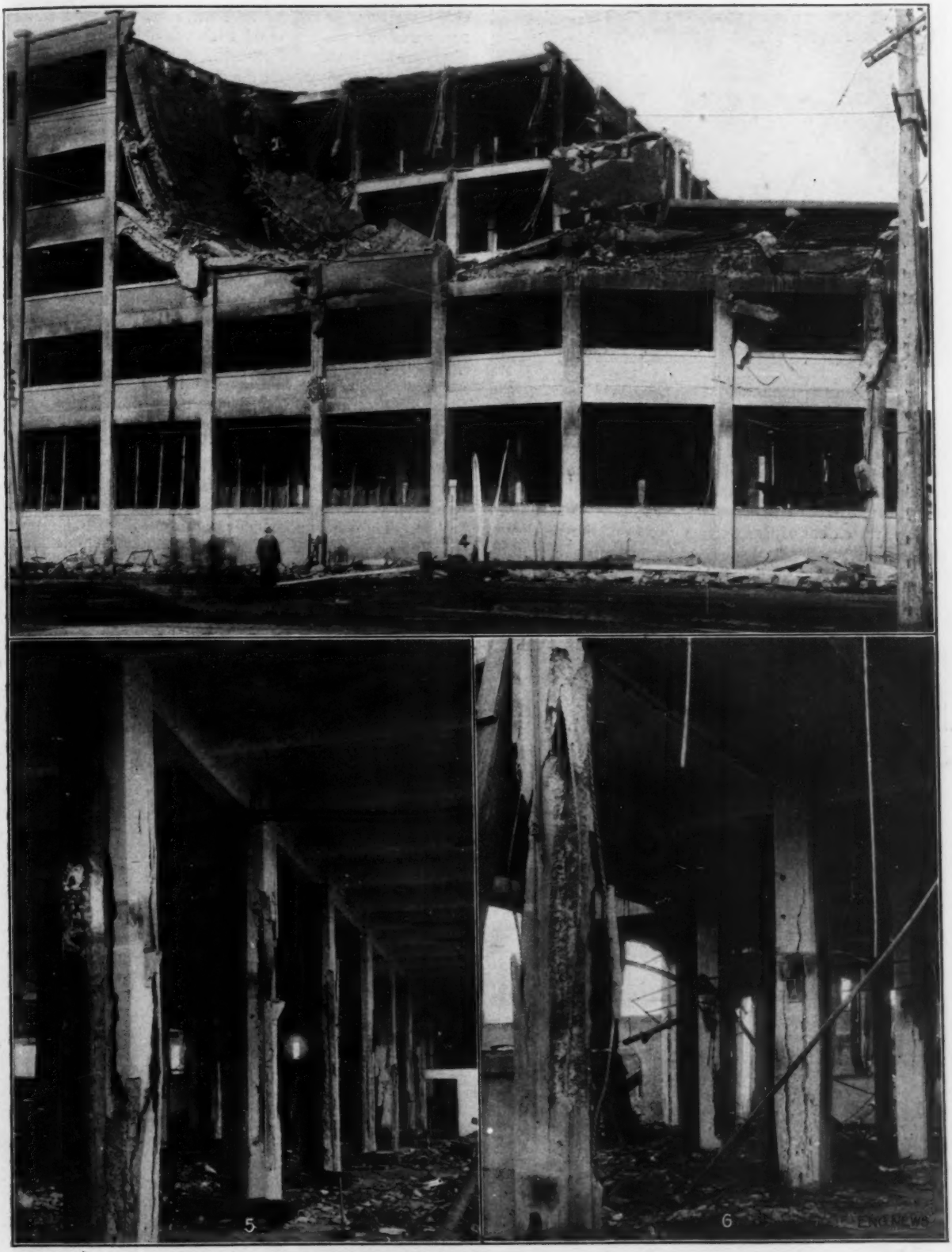


FIG. 4. THE ONLY COLLAPSE IN THE EDISON FIRE

(Heavy machinery was stored on the upper two floors.)

FIGS. 5 AND 6. FURTHER EXAMPLES OF INTERIOR COLUMN FAILURE

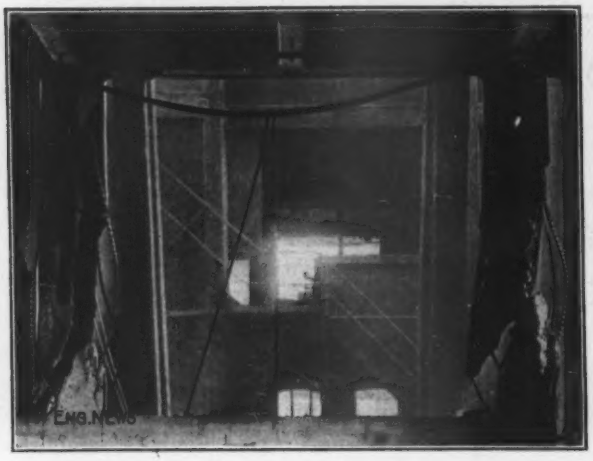


FIG. 7. REINFORCED-CONCRETE COLUMNS DESTROYED BY FIRE AT THE EDISON PLANT

in the path of the fire was gutted of contents. The fire readily broke through the glass windows and, aided by the inflammable contents and wooden trim, soon destroyed everything except the concrete frame. The view in Fig. 1 shows the extent of this damage in two of the buildings, a condition practically duplicated in all the rest. Counting certain wings as separate structures, there were seven large buildings thus affected.

In most of the concrete buildings the concrete has stood up remarkably well. With machines reduced to scrap and the floor covered with the débris from burnt phonograph records and with the wooden sleepers burned out from their grooves in the concrete floor, the concrete itself is remarkably free from cracks and spalls. In two of the buildings, however, the destruction of concrete, particularly of the columns, is more serious than has ever before been noted in concrete buildings under fire.

The views in Figs. 2, 4-8 show the conditions in these buildings. It will be noted that the common type of failure is in the straight-rodded column and its progression can be studied in different columns in the views. Evidently the action is as follows: Under the heat of the fire the longitudinal steel rods (which were only at the four corners and evidently not tied horizontally) expand, and in expanding force off the outside coating of concrete. Once exposed, they are free to expand farther and, in their softened condition, to bend under load until finally the weakened section of concrete crushes under the load, the column drops and the rods bow out almost in a loop. Fig. 3, a view in the first floor of the phonograph warehouse, where the packed machines made a very hot fire, shows the secondary stage in this failure. Practically every column in this building is shivered vertically at the reinforcing rods and many are reduced in section or broken. The whole seven-story building is still standing on columns which can hardly have 40% of their original section.

The views in Figs. 3 and 8 show the third floor of the phonograph-cylinder shop, a floor on which were thousands

FIG. 8. OUTSIDE OF DICTATING RECORD BUILDING, SHOWING THIRD-FLOOR COLUMNS DESTROYED

(The heat of the third floor, the highest floor in this view, was very intense on account of the presence of many wax records. Water from the few fire engines which could get near the plant was played continuously on these columns, which probably accounts for their failure while the columns all below and above were intact.)

of the wax dictating records and which was subjected to the hottest kind of a fire. It is evident that concrete heated almost to incandescence is much more apt to break down and spall if wet down than if left to cool naturally. This may account for the condition of the columns on this third floor. The fire here was much hotter than on the other floors of the same building and was the main point of attack of the engines, which were able to take a near-by stand for a time at least. The third-floor columns are in the last stage of failure and have dropped from one to two feet, carrying the floors in a sag, but in no case causing total collapse. The remaining floors of the building are remarkably free from cracks and breaks.

The hooped columns were in the building where were stored undeveloped moving-picture films and which was burned out. The precise nature of their design is not now available, but the one column that is stripped in one small patch shows a heavy expanded-metal cylindrical covering. All the columns on the floor are practically intact.

In many of the views cracks in the beams and girders may be noted. In every case these are over reinforcement, which has expanded as in the columns, and forced off the concrete covering. The depth of this covering varies, but in most cases it is equal to or greater than the 2 in. required in modern practice.

At one point only were the column failures of sufficient extent to cause collapse, and that was at the corner of the upper floors of a six-story factory, on which floors heavy machinery was located. The collapse is shown in Fig. 4. It is rumored that the largest explosion of the night took place at this point and caused the collapse, but it appears that the failure of some corner columns was the initial cause. The behavior of the lower floors and of the adjoining building in standing up under this heavy impact testifies to the integrity of the structure against mere load conditions.

At the present stage of investigations there is no definite record of differences of age or peculiarities of material, design or temperature conditions during the fire which might cause the different effects on the various buildings. To a somewhat superficial examination, the structure in all of the buildings is equally good; the concrete seems to be admirable. How far the peculiar fire or explosion conditions resulting from the permeating volatile oils which were present in the plant are responsible for damage is also a matter that may be cleared up in the thorough investigation which it is hoped may soon be under way.

NEWS NOTES

A High Wind Lifted a Steel Stack at the Flatbush Water-Works, Brooklyn, N. Y., and carried it 50 ft. through the air, dropping it through the roof of a house, where it fell through the ceiling into the room below, on Dec. 8. No one was hurt. The stack spent the night in the house. The next morning derricks were placed for its removal.

An Acetylene Tank Exploded in a junk yard at Hagerstown, Md., on Dec. 5. The gas was used in the cutting of scrap iron. The tank exploded when a match was applied to the end of the tube leading from it. One man was killed and another injured.

A Pipe Plant Burned in Birmingham, Ala., on Dec. 6, belonging to the Southern Sewer Pipe Co. The main building, 500x80 ft., three stories high, of brick and wood, was destroyed. The total damage was estimated at $100,000. The manager stated that the plant would be rebuilt.

Collisions on Elevated Railways, New York—On Dec. 9 a local northbound train on the Ninth Ave. Elevated Ry. crashed into the rear of an express train standing at a station. Two persons were killed and 18 injured. Preliminary investigation by the Public Service Commission developed the fact that the local was being operated from the fourth car, on account of derangement of the electric control machinery in the first car. The motorman depended for guidance upon signals given him by a conductor stationed on the rear platform of the first car. This car telescoped the rear car of the express train and both took fire from the third rail and were consumed. A public inquiry into the accident was scheduled for Dec. 16 by the Public Service Commission. On Dec. 11 a local southbound Sixth Ave. train struck the rear of a Ninth Ave. local standing at 150th St. Seven persons were injured. The motorman was driving from the first car. He is reported to have stated that he did not see that the train ahead had stopped, until it was too late to avoid collision.

Macadam Pavements Have Been Laid in Winnipeg, Man., since 1894, to a total of nearly 600,000 sq.yd. Since 1901 nearly 165,000 sq.yd. have had to be removed.

The Field Work of the Topographical Survey of Ohio has been about completed by the United States Geological Survey. It is expected that all the sheets not yet published will be available within two years.

The Proposed Freight Terminal of the Lehigh Valley R.R. at Buffalo, N. Y., requires the demolition of 30 buildings on the ¼-mile square, recently purchased by the railway for $1,200,000. Most of the buildings are small frame stores and dwellings, and their demolition is under way at the present time.

A Bill for Licensing Engineers is, according to report, again to be introduced in the New York legislature, which assembles on Jan. 1. The bill originates with the Technical League of New York, and it is supposed will follow generally the lines of the bills pushed by that organization in previous years.

The U. S. Steamboat Inspection Service in the year ending June 30, 1914, inspected 7930 vessels, with a gross tonnage of nearly 10,000,000. There were 232 accidents during the year on vessels subject to inspection, resulting in a loss of 105 passengers and 477 members of the crew. One passenger was lost for each 3,029,000 passengers carried. The report recommends legislation to require fireproof construction on all excursion steamers hereafter built, and that the designs for the hulls and boilers of all vessels hereafter built should be first examined and approved by a corps of inspectors in the office of the supervising inspector general.

3512 Men on Panama-Pacific Exposition Construction—A census of employees of the Panama-Pacific Exposition on Nov. 1, showed a total of 3512 men engaged on construction work. This force was distributed as follows:

Exposition board of works, engaged on main buildings	723
State and foreign buildings	1060
Concessions	663
Exhibits	96
Office force	298
Landscape gardeners	99
Firemen	74
Sculptors	40
Clearing grounds	339
Guards	120

The Standard Form of Building Contract adopted by the American Institute of Architects is in process of revision by a committee of the Institute in coöperation with a committee of the National Association of Builders Exchanges. At a joint meeting in Philadelphia in September last, a preliminary draft of the revised form was prepared, and this revised form has now been printed for further discussion at the annual meeting of the American Institute of Architects to be held in Washington this month. Copies of the revised draft can be obtained from the General Commissioner of the Builders' Exchanges Association, Mr. I. H. States, 15 East Fayette St., Baltimore, Md.

A Municipal Refuse-Utilization Plant is being built by Columbus, Ohio. The salable refuse will be picked from an inclined conveyor belt and baled. The tailings will be burned in a two-cell Stirling furnace, built by the Griscom & Russell Co., New York City. The cells will have a rated capacity of about 45 tons a day. Steam generated by a 150-hp. boiler will be utilized at the near-by municipal electric-lighting plant. T. D. Banks is Superintendent of Garbage Reduction and Refuse Disposal at Columbus. The plans for the refuse-utilization plant were originally made by Ira S. Osborn, but have been remodeled somewhat by J. J. Morgan, Commercial Building, Columbus. The abandoned West Side pumping station is being remodeled to house the refuse-utilization plant.

To Provide for Unemployed Men in Los Angeles County, Calif., the board of supervisors has authorized road work which will require 400 men at once and arrangements are under way to authorize work requiring 1500 men. In this work married men who have lived in Los Angeles County one year will be given preference.

The Chicago River Protective Association has been organized by a group of property owners. Its purposes are to promote the navigability of the river and prevent its further obstruction, to secure the removal of the center-pier drawbridges and other obstructions, to secure a width of 200 ft. and a depth sufficient for modern commerce, and to aid in formulating a plant for the solution of the drainage problem of Chicago. C. W. Stevens is chairman of the association.

Better State Highway Legislation is the object of a committee to work for revision of state road laws appointed by the directors of the American Highway Association on Dec. 1. The committee consists of Walton Moore, of Washington; Chas. J. Bennett, State Highway Commissioner of Connecticut; A. N. Johnson, Chief Engineer, Bureau of Municipal Research, New York City; Francis J. Caffey, of the Department of Agriculture, and J. E. Pennybacker, Chief of Road Economics, U. S. Office of Public Roads.

Adequate Survey of Pacific Needed—In his annual report, made public on Nov. 22, Secretary of Commerce Redfield emphasized the need of legislation and money for the protection of commerce and safeguarding vessels against needless destruction. The immediate need for three vessels for survey work along the Alaskan coast was pointed out. He said: "Our citizens have been drowned (31 in one case), and both private and public property repeatedly lost, because the United States Government has not more rapidly provided the force and apparatus with which to survey and chart the dangerous waters of our Pacific and particularly of our Alaskan coasts."

Geared Steam Turbines for ocean steamship propulsion have been adopted on the "Transylvania," the new Cunard transatlantic steamship of 15,000 tons which arrived in New York Nov. 17. According to "The Engineer," of London, the propelling machinery of the vessel consists of two sets of Parsons steam turbines, the high-and low-pressure drums being on separate shafts. Each turbine shaft carries a helical spur gear in mesh with a gear wheel on a propeller shaft. The gear reduction is 12½ to 1, and the propeller shafts are to run at 120 revolutions. With both sets of turbines developing 9000 hp. it is expected to give the ship a speed of 15½ knots.

The Building of Wooden Passenger Cars has ceased in the United States. The report of the Committee on Rails and Equipment to the National Convention of State Railway Commissioners in Washington last week showed that of 3144 passenger train cars under construction on Jan. 1 last, 86.9% were of steel, 12.6% had steel under-frames, and only ½ of 1% were of wood. Only two of these were intended for the use of passengers. The number of steel and steel under-frame passenger cars in service on Jan. 1 was about 14,000, and the number of wooden cars about 44,560. It is also becoming common to use steel ends for cars having steel under-frames and wooden upper construction.

A River Straightening Job at Dayton, Ohio, part of a larger project which had been planned before the great flood of 1913, has just been completed under the direction of the Public Service Department of the city. The original intention was to spend several hundred thousand dollars in making a cutoff through a bend in the river in the lower part of the town. After the flood, the main project was held in abeyance pending the result of investigation of still broader flood prevention plans. A small part of the original contract was, however, carried out by Gebhart & Kline, contractors, of Columbus. The work just completed will not interfere at all with whatever plans may finally be adopted for protecting the entire city and valley.

Fast Third Tracking on Second Ave. Elevated Ry., New York—The contract for fabricating and delivering 106 new steel girders for the construction of a third track on the Second Ave. elevated line of the Interborough Rapid Transit Co., between 51st and 60th St., New York, was awarded to the McClintic-Marshall Construction Co. on Sept. 23, 1914. The last shipment of this steel left the shop on Nov. 16 and arrived at Communipaw on Nov. 20. Four lighters of the Lighterage Co. delivered the steel to New York dock, Nov. 23-25. Four-horse swing trucks hauled it to the site. The 53 spans, weighing 459 tons, and one old span of seven tons were erected by the Terry & Tench Co. in three eight-hour days (Nov. 23-25). In seven eight-hour days, 5400 rivets were driven, 2160 bolts set and 1728 holes drilled.

Changes in Lime Handling at the Cincinnati Water-Filtration Plant have just been completed. The lime was formerly received in cotton duck sacks, each holding 100 lb. It is now bought in bulk in carload lots and passed through a swing-hammer crusher, direct connected to, and driven by, a 25-hp., 220-volt, direct-current electric motor. The lime is shoveled from railway cars to the hopper of the crusher. The crushed lime is discharged into the boot of an elevator and carried to the second floor of the chemical house of the filtration plant, where it is dropped into a drag conveyor hung from the ceiling of the chemical-house roof. The valves in the bottom of the conveyor drop the lime into a room which has been partitioned off in the chemical house by corrugated iron. The elevator and conveyor are operated by a 7½-hp. motor. These improvements cost about $2500. The new method of handling lime will save at least 50c. per ton and perhaps more on the cost of the lime alone, besides a saving in freight for the return of empty sacks to the kilns to be refilled. The cost of the labor for unloading will also be less. Altogether the annual saving will probably be about $1000 a year. J. W. Ellms is Superintendent of the Cincinnati Filtration Plant, and J. A. Hiller is General Superintendent of the Cincinnati Water-Works.

The Centennial Anniversary of the Steam Printing Press has just occurred. On Nov. 29, 1814, the issue of "The Times," of London, England, was for the first time printed by steam power. The machine used was a cylinder printing press, also the first of its kind ever produced. A full description is given in the "Times" Engineering Supplement of Nov. 27, 1914. This steam press was invented by Friedrich König, a native of Eisleben, Saxony, the birthplace of Martin Luther. König was a printer's apprentice at Leipzig, and after making various inventions which found little appreciation in his native country, he emigrated to England in 1806 and obtained the financial assistance of Thomas Densley, a printer. The general principle of the cylinder press had been developed by an English inventor, William Nicholson, in a patent dated 1790, but Nicholson was without means and was in fact found by König in a debtor's prison. König's designs, which he patented in 1811, were taken up by John Walter, the head of the London "Times," and after three years of patient labor the first cylinder press driven by steam power was completed. This machine printed one side of a sheet at the rate of 1100 copies an hour, and was later improved to reach 1800 copies an hour. Three years later the machine was improved by König to print on both sides of the sheet.

A New Railway Route between the Northwest and the Gulf ports has been established by the completion of the Chicago, Burlington & Quincy R.R. extension from Casper to Orrin Junction, Wyo., about 70 miles. This completes a low-grade line from Billings, Mont. (on the Northern Pacific and Great Northern railways), to Orrin Junction, 340 miles; there connections is made with the Colorado & Southern Ry. to Denver and Gulf ports. These four railways are owned by the same interests. The maximum grades on the new line are mainly 0.3%, with two pusher sections having grades of 0.5 to 1.5%. The maximum curvature is 2° on most of the line, and 4° in some parts. There is some very heavy construction, and the line traverses three deep and narrow cañons, the Wind River cañon being about eight miles long. For about 100 miles west of Orrin Junction the new line parallels the Chicago & Northwestern Ry. line to Lander, Wyo., both lines following the Platte River.

Two extensions or links in the Burlington system are projected east of Orrin Junction; one from Bridgeport to Newark, Neb., and the other from St. Joseph to Mexico, Mo. These will complete a low-grade line from the Ohio River at Metropolis, Ill., and the Mississippi at St. Louis, to the Northwest and Pacific ports. The new Ohio River bridge and connection between Metropolis, Ill., and Paducah, Ky. (now under construction), will also establish connection with the South.

Conference of Hydraulic Engineers—A conference of hydraulic engineers engaged in water-resource investigations was held last week at the offices of the Water Resources Branch of the Geological Survey at Washington, D. C. In the investigation referred to, the country has been divided into 14 districts, including Hawaii. The district engineers from each of the districts attended the conference. The New York State Conservation Commission and the Maine Public Service Commission were also represented. In addition, there were present representatives from the Indian Office, Bureau of Standards, Office of Experiment Stations, Forest Service, Weather Bureau, and Reclamation Service. The following Canadian organizations were represented: Hydrographic Survey of Manitoba; Water Power Branch, Department of Interior, Ottawa; Water Power Branch of Ontario; Department of Public Works, Ontario. The program consisted of a series of papers covering the field of hydrographic investigation and, in addition, there was an exhibit of instru-

ments and equipment used in hydrographic work. The following papers were included in the program: "Standardization of Equipment," G. L. Parker; "Refinement Justified in Field Equipment and Methods," C. C. Covert and W. A. Lamb; "Automatic Gages"; "Work of Groundwater Division," O. E. Meinzer; "Method of Correcting River Discharge for a Changing Slope," B. E. Jones; "Determination of Drainage Areas" J. H. Morgan. Further information can be obtained by addressing John C. Hoyt, Hydraulic Engineer, in charge of Division of Surface Waters, U. S. Geological Survey, Washington, D. C.

Alum for Water Coagulation at the water-purification plant of Columbus, Ohio, will be manufactured by the city in a plant which it is expected will be put in operation by Dec. 15. Either bauxite or halloysite will be bought in carload lots. The ore will be dumped into a crusher beneath the floor. The crushed material will be lifted by an elevator which will discharge the bauxite into a pulverizer where it will be powdered so fine that 90% will pass through a screen having 200 meshes per in. The halloysite will not be pulverized, as it gives better results when merely crushed to the size of grains of crushed corn. The crushed and pulverized bauxite, or the crushed halloysite, as the case may be, will be elevated to lead-lined tanks, where it will be treated first with sulphuric acid, then boiled with steam to complete the reaction. The material will then be diluted with water and the proper quantity drawn off into a measuring tank on a lower level, and from there ejected to a chemical-solution tank. From the latter the solution will be fed into the water to be treated. Any suspended matter present in solution will settle out in the regular sedimentation basins. Commercial alum now costs about $17 per ton, f.o.b. at Columbus. It is expected that the new plant will produce alum at about $12 a ton. The plant will cost about $12,000. One ton of bauxite will make 2½ tons of 17% alum (Al_2O_3). The new alum plant will be operated about two days a week, on different days, by only one man. The plant was designed and is being built by C. P. Hoover, Chemist-in-Charge of Water Purification Plant, Columbus, Ohio. Jerry O'Shaughnessy is Superintendent of the Columbus Water-Works.

PERSONALS

Mr. G. Masunaga, Electrical Engineer of the Imperial Government Rys., Tokyo, Japan, is in this country inspecting electrified railways.

Mr. E. Wanamaker has been appointed Electrical Engineer of the Chicago, Rock Island & Pacific Ry., succeeding Mr. F. J. Glover, resigned.

Mr. George Bird, of Harrisonville, Mo., has been appointed Chief Engineer of the Grand River Drainage District of Cass and Bates Counties, Missouri.

Mr. Ivy L. Lee, recently Executive Assistant of the Pennsylvania R.R., has been appointed a member of the personal staff of Mr. John D. Rockefeller, of New York City.

Mr. James R. Valk has been appointed Western Sales Manager of the United States Asphalt Refining Co., New York City, with offices in the Harris Trust Bldg., Chicago.

Mr. Charles Hurdleston, formerly Division Superintendent of the Missouri, Kansas & Texas Ry., has been appointed Manager of the Texas State R.R., with headquarters at Rusk, Tex.

Mr. F. C. Elliott, a lawyer, of Chicago, Ill., has been elected President of the White Pass & Yukon Route, with headquarters in Chicago, succeeding Mr. O. L. Dickeson, who recently resigned.

Mr. E. P. Laird, Engineer of Roadway of the Atlantic Coast Line R.R., at Rocky Mount, N. C., has been promoted to be Superintendent of the Richmond district, with office at Richmond, Va.

Mr. Dale S. Cole, Assoc. Am. Inst. E. E., formerly Electrical and Mechanical Engineer of the Globe Stove & Range Co., Kokomo, Ind., is now Superintendent of the Reliance Gage Column Co., Cleveland, Ohio.

Mr. F. D. Egan, M. Am. Inst. E. E., Electrical Engineer of the Pittsburgh Crucible Steel Co., Midland, Penn., has been appointed Steam and Hydraulic Engineer of the company in addition to his present duties.

Mr. H. C. Westover, Assoc. M. Am. Soc. C. E., formerly of the firm of Rollins & Westover, Consulting Engineers, Kansas City, Mo., has opened an office at Beaumont, Texas, to practice municipal engineering.

Mr. F. L. Bunton, M. Am. Soc. M. E., recently Manager of the Chicago office of the Heine Boiler Co., is now Manager of the Chicago office of the Goulds Manufacturing Co., with headquarters at 3801 South Ashland Ave.

Mr. John H. Roemer, Chairman of the Wisconsin Railway Commission, is to join the organization of H. M. Byllesby & Co., of Chicago, Ill., on Feb. 1, 1915. He will be in charge of the legal business of the organization.

Mr. J. M. Tomlinson, of Bridgeport, Conn., Acting Vice-President and General Auditor of the New York, New Haven & Hartford R.R., has been elected Vice-President and Comptroller, succeeding Mr. H. M. Kochersperger, resigned.

Mr. John A. Hense, formerly with the National Malleable Castings Co., Chicago, and recently with the Dravo-Doyle Co., Philadelphia, has been appointed Manager of the St. Louis, Mo., office of the Kerr Turbine Co., of Wellesville, N. J.

Mr. L. C. Bewsey, recently Superintendent of the Indianapolis division of the Union Traction Co., of Indiana, has been appointed Superintendent of Transportation of the Buffalo, Lockport & Rochester Ry. Co., with headquarters at Rochester, N. Y.

Mr. George H. Mueller, for some time Chief Engineer and now Assistant Sales Manager of the Jeffrey Manufacturing Co., Columbus, Ohio, will become District Manager of the New York office of the company on Jan. 1, 1915, with offices at 77 Warren St.

Mr. Kempter B. Miller, M. Am. Inst. E. E., of the firm of McMeen & Miller, Consulting Engineers, Chicago, Ill., has been appointed Chief Engineer for the receivers of the Central Union Telephone Co. He will continue to make his headquarters in Chicago.

Mr. H. C. Oviatt, recently Superintendent of the Old Colony division of the New York, New Haven & Hartford R.R., has been appointed Assistant Mechanical Superintendent in charge of a new bureau known as the Bureau of Fuel Economy, with headquarters at New Haven, Conn.

Mr. A. E. Seelig, former Sales Manager of the L. J. Wing Manufacturing Co., New York City, recently Manager of the machine tool department in the New York City office of Schuchardt & Schütte, has been appointed General Sales Manager of the Kerr Turbine Co., Wellesville, N. Y.

Mr. W. E. Smith, Superintendent of Construction of the Louisville & Nashville R.R., Louisville, Ky., has been appointed Superintendent of the Louisville and Nashville divisions, with headquarters at Evansville, Ind., succeeding Mr. John W. Logsdon, temporarily retired on account of ill health.

Messrs. Frederick Holbrook and W. S. Patton, of the Holbrook, Cabot & Rollins Corporation, General Contractors, New York City, sailed for France, Saturday, Dec. 5. It is reported that the firm has large contracts for rebuilding French bridges under consideration. At present the firm has several subway contracts in New York City.

Maj. Gen. William W. Wotherspoon, U. S. A., retired, is to be appointed Superintendent of Public Works of New York State under the administration of Governor-Elect Whitman, according to press announcements. Gen. Wotherspoon was born in 1850 and was appointed a Second Lieutenant of Infantry from civil life in 1873. All his army service was with the infantry branch of the service. At the time of his recent retirement he was Chief of Staff of the United States Army. The salary is $6000 per annum.

Messrs. George C. Whipple, M. Am. Soc. C. E., Consulting Engineer, New York City, and Professor of sanitary engineering at Harvard University; W. T. Sedgwick, Professor of biology and public health at the Massachusetts Institute of Technology; Milton J. Rosenau, Professor of preventive hygiene at Harvard University; William J. Gallivan, a physician, of Boston, Mass.; David L. Edsall, Professor of clinical medicine at Harvard Medical School, and Joseph E. Lamoreaux, a physician, of Lowell, Mass., have been appointed members of the advisory council to the Massachusetts State Commissioner of Health, Allan J. McLaughlin.

Mr. Maxwell Carson Maxwell, M. Am. Soc. M. E., for the past seven years head of the Department of Applied Mechanics, Pratt Institute, Brooklyn, New York City, and a consulting engineer, has become identified with the Yale & Towne Manufacturing Co., of Stamford, Conn. He is now Superintendent of Power and Plant and is responsible for the power generation and distribution, the building maintenance, all new building construction, the general repairs and maintenance of all machinery, shafting, etc., throughout the plant. He also has charge of the tool department, being responsible for all tool designing, the machine shops for building tools and the forge shop.

Mr. William B. Landreth, M. Am. Soc. C. E., City Engineer of Schenectady, N. Y., has been appointed Deputy State Engineer of New York under the State Engineer-Elect.

Frank M. Williams, M. Am. Soc. C. E. Mr. Landreth is a graduate of Union College, class of 1881, and after three years' experience in railway work in Mexico, was City Engineer of Schenectady for three years. Later, he was Engineer of the Board of Public Works of Amsterdam, N. Y., and in charge of city work at White Plains, Port Jervis and Jamestown, N. Y., and Athens, Penn. In 1897 he was appointed Assistant Engineer of the New York State Barge Canal; in 1900 he was made Special Resident Engineer, and in 1919 Special Deputy State Engineer in charge of the Barge Canal.

Mr. T. Coleman Du Pont, President of the E. I. Du Pont de Nemours Powder Co., of Wilmington, Del., has announced that he is still willing to contribute a 100-mile boulevard to the State of Delaware, if the United States Supreme Court decides that the law passed by the Delaware legislature giving the road organization authority to acquire land for right-of-way by condemnation proceedings is constitutional. The work of construction was begun about two years ago, but was held up by a farmer who sought to prevent the condemnation of his land. The Delaware court decided against the farmer, who then appealed to the U. S. Supreme Court. The farmer subsequently died and his heirs declined to continue the suit. The Supreme Court recently dismissed the suit without a ruling on the constitutionality of the law, and it will be necessary to institute another suit to get a decision on his point.

OBITUARY

Charles Arthur Moore, President of Manning, Maxwell & Moore, New York City, died recently on the steamship "Rotterdam" while en route to Naples, Italy.

William David Cantillon, former General Manager of the Chicago & Northwestern Ry., died at his home in Chicago, Ill., Dec. 13. He was born in 1861 and entered the service of the Chicago & Northwestern Ry. as a brakeman in 1883.

Jesse H. Waters, President and General Manager of the Florence & Cripple Creek R.R., died Nov. 27 at Colorado Springs, Colo., from injuries received on Nov. 25, when a railway motor car in which he was riding collided with a locomotive.

Eli Stillson Hart, Chairman of the Board of Directors of the Rodger Ballast Car Co., Chicago, Ill., died Nov. 23. He was born in Rochester, N. Y., in 1832, and was educated as a lawyer. In 1874 he gave up the practice of law and was one of the founders of the Rodger Ballast Car Co.

Horatio Bankson Cooper, a retired civil engineer, died Dec. 1 at his home in Lancaster County, Va., aged 68 years. He was born in Baltimore, Md., and for many years had charge of construction work for H. A. Ramsay & Co., of Baltimore, including the Richmond, Va., water-works and the St. Paul St. Bridge, Baltimore.

Col. E. D. Meier, Past-President of the American Society of Mechanical Engineers, died Dec. 15 at his daughter's home in New York City. He had been in ill-health for several months. A portrait and biographical sketch were published in "Engineering News," Feb. 2, 1911, at the time of his election to the presidency of the American Society of Mechanical Engineers.

Alfred E. Hennig, a member of the staff of Mr. Charles T. Main, M. Am. Soc. C. E., of Boston, Mass., attached to the Western office under Mr. Henry A. Herrick, M. Am. Soc. C. E., Great Falls, Mont., died Dec. 6 from cancer of the stomach. He had been associated with Mr. Main since 1898. Recently he had been in charge of construction work in Montana.

Walter B. Thomson, Division Engineer of the Pennsylvania R.R., at Williamsport, Penn., died Nov. 28, at his home in Williamsport. He was born at Mt. Savage, Md., in 1867. He attended Lafayette College for two years and then entered the engineer corps of the Pennsylvania R.R. as a rodman. He was promoted through various grades to be Division Engineer in 1901.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 14-18. Convention at Chicago, Ill. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-30. Annual meeting at Chicago, Ill. Secy., F. M. White, Madison, Wis.

SOCIETY OF CONSTRUCTORS OF FEDERAL BUILDINGS.
Jan. 4-6. Convention at Washington, D. C. Secy., T. R. Maul, 4213 Westminster Ave., Philadelphia, Penn.

ASSOCIATION OF GOVERNMENT CONTRACTORS.
Jan. 4-7. Annual meeting at Washington, D. C. Secy., Algernon Blair, Montgomery, Ala.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 15. Annual meeting at New York City. Secy., J. R. Wemlinger, 11 Broadway, New York City.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 19-21. Convention at Chicago, Ill. Secy., F. J. Angier, Mt. Royal Station, B. & O. R.R., Baltimore, Md.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 20-21. Annual meeting in New York. Secy., Charles Warren Hunt, 220 W. 57th St., New York City.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS.
Jan. 20-22. Annual meeting at New York City. Secy., J. J. Blackmore, 29 W. 39th St., New York City.

AMERICAN CONCRETE INSTITUTE.
Feb. 9-12. Convention at Chicago, Ill. Secy., E. E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 15-16. Annual convention at Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

St. Louis Railway Club—The Christmas entertainment of the St. Louis Railway Club will be held in the auditorium of the American Hotel Annex on the evening of Dec. 18. The Secretary is B. W. Freunthal.

Seattle Association of Members of the American Society of Civil Engineers—At the November meeting of the Association representatives of the various technical societies of Seattle were present to discuss the feasibility of a federated union.

American Society of Civil Engineers—George A. Harwood has been nominated for Director of the Society (first district) on an independent ticket, as against the regular nominee, Frederick Molitor. The other nominations were noted in our issue of Oct. 22.

American Institute of Architects—At the 48th annual convention held in Washington, D. C., Dec. 2-4, the following officers were elected: R. Clipston Sturgis, President; Thomas R. Kimball, First Vice-President; D. Knickerbacker Boyd, Second Vice-President; Burt L. Fenner, Secretary; John Lawrence Mauran, Treasurer.

Southern California Association of Members of the American Society of Civil Engineers—At the annual meeting of the Association, held at Hotel Clarke, Los Angeles, Calif., Dec. 9, the election of the following officers was announced: President, Capt. C. T. Leeds; Vice-Presidents, H. Hawgood, G. S. Binkley, Charles H. Lee, W. K. Barnard. The membership of the Association is now 93.

St. Louis Engineers' Club—At the recent annual meeting of the Club it was voted to appropriate $1000 of the general funds as the beginning of a building fund for the construction of a new home for the Club. It is hoped that the new building will be completed before the end of 1915. The results of the annual election will be announced at the annual banquet at the City Club on Dec. 16. The nominees for President are E. L. Ohle, H. J. Pfeifer, and J. W. Woermann.

Highway Engineers' Association of Missouri—The eighth annual meeting of the Association is being held at Jefferson City, Mo. (Dec. 17-18). Among the papers presented are the following: "Reinforced Concrete," by E. Lee Heidenreich, Kansas City; "City Streets and Country Roads," by C. M. Talbert, St. Louis; "Cost Keeping," by F. D. Hughes, Kansas City; "Power Road Machinery," C. M. DeWind, Chicago, Ill.; "Oiled Dirt Roads," by B. H. Burrell, U. S. Dept. of Public Roads. The Secretary is Howard M. Shirkey, Richmond, Mo.

New England Water Works Association—The December meeting was held in Boston, Dec. 9. After the usual luncheon two papers descriptive of small town water-supplies were read. The first, by D. N. Tower, Superintendent of the Water Co. of Cohasset, Mass., described numerous difficulties experienced in finding and maintaining a water-supply for a now famous summer resort and former fishing town, built on a series of rocky points extending into Boston Harbor. Water was originally obtained from wells driven into sand pockets in the ledges. This water turned out to be highly colored and unsatisfactory, and recourse was had to ponds of similar water and a filter plant. For only a few hundred services, and many of these used only in the summer time, five small pumping plants are maintained. The second paper, by George F. Merrill, Superintendent of Water-Works, described the water-supply of Greenfield, Mass., which consists of two distant gravity reservoirs, one storage reservoir near the town, and a recent additional supply consisting of a 25-ft. well and a 3,000,000-gal. pumping plant. The common fault of this and all early water-works was said to be the use of mains too small for adequate fire protection. About an hour was devoted to further discussion of the subject of service pipes, begun at the November meeting.